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THESIS

JUST-IN-TIME CONTRACTING IN
THE DEPARTMENT OF DEFENSE

by

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Just-In-Time Contracting in the Department of Defense

by

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ABSTRACT

Just-In-Time is a production process that has revolutionized the automobile, as well as many other industries over the past forty years. The major issue in this thesis is: "What is the potential impact of implementing Just-In-Time practices into the contracting process in the Department of Defense?" The thesis focuses on the production process of the T56 engine that is reworked at the Naval Aviation Depot Facility at Alameda, Ca. The objective is to determine the feasibility of implementing Just-In-Time contracting practices in the procurement of selected parts for the T56 engine. The intent is to determine if utilizing this process will reduce the inventory costs and improve the quality of parts received from Department of Defense contractors. The Just-In-Time process provides a more efficient method of doing business by eliminating waste in the production process. The Department of Defense can experience significant benefits from implementing Just-In-Time practices and should pursue the implementation of this process.

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I. JUST-IN-TIME CONTRACTING IN THE DEPARTMENT OF DEFENSE

A. BACKGROUND

The most dramatic change in the economic world in the past thirty years has been the evolution of Japan and the Far East Basin's development into economic capitals of the world. Once the antithesis of a country that produced quality goods, Japan is now a country whose name is now synonymous with quality. They have exceeded the United States and West Germany as the most powerful and productive economic nation in the world. There are many factors that have lead to Japan's meteoric rise to the top, and a contributing factor to this rise has been the implementation of a production process called Just-In-Time (JIT).

Just-In-Time has been so successful in Japan that many U.S. firms have implemented this process and experienced significant cost reductions and quality improvements. Most of the success stories in JIT have come from firms that are in a manufacturing industry that requires a continuous flow of a production line, such as the assembly line at the Ford Motor Company. Many of the automakers in this country have implemented JIT in an attempt to slow the erosion of market share that the American automakers once dominated for so many years. If JIT is so successful in Commercial industry, what

areas of the Department of Defense (DoD) could utilize this highly successful production process?

Although JIT is already utilized in many DoD commands to reduce inventory levels, there are only a handful of commands that are utilizing this process in an actual production mode. With the exception of the Ammunition plants, DoD relies on the private sector to produce its product. The purpose of this thesis is to examine the feasibility of utilizing Just-In-Time contracting practices in a production process in the Department of Defense. The rework of aircraft engines at the Naval Aviation Depot (NADEP) in Alameda, CA was chosen as the test site for this feasibility study due to its direct correlation to a production process and its close proximity to the researcher.

B. OBJECTIVE

The objective of the study was to analyze the rework process of a selected aircraft engine to determine if the Just-In-Time concept could achieve any cost savings or improved levels of quality in the most often replaced parts. By analyzing the complete acquisition process, the researcher was looking for ways to improve the process.

C. THE RESEARCH QUESTION

The primary research question was: "How can Just-In-Time contracting procedures be used to the greatest benefit in

Maintenance and Overhaul Activities in the Department of Defense? The subsidiary research questions were:

- What is Just-In-Time Contracting?
- What are the principal applications of the JIT concept to Navy maintenance functions?
- What problems must be resolved in order to apply JIT procedures in Naval Aviation Depots?
- What problems must be resolved in order to apply JIT procedures at Department of Defense Contractors?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

The study focused only on the T56 aircraft engine and the rework of that engine at the NADEP Alameda, Ca. The process at Alameda was analyzed to discover areas that could benefit from the implementation of this process. In addition to NADEP Alameda, the production process of various Defense Contractors was also analyzed. Although many other engines are reworked at NADEP Alameda, the T56 engine was the only engine included in this study. Although the T56 is also being reworked by the Air Force at Kelly AFB, San Antonio, TX, that process was not included in this study. There were no additional limitations to the study.

The major assumption in this study is that the reader is familiar with the Department of Defense and some of the various aviation components within the Department of the Navy. In addition, it is assumed that the reader is familiar with

the significant economic growth of the Far Eastern nations in the past few decades.

E. LITERATURE REVIEW AND METHODOLOGY

The literature used in this study consisted of periodicals such as Purchasing Manager, Purchasing, Management Accounting and the Journal of Purchasing and Materials Management. Case studies from such commands as the Naval Supply Center Jacksonville, FL, and the U.S. Army Materiel Command in Lexington, KY, were also used. Referenced books on the subjects of Japanese Manufacturing Techniques by Richard Schonberger and two books on Just-In-Time Purchasing by Peter Grieco and A. Ansari were also included in the research. In addition to the literature, interviews, both personal and telephonic, were conducted with commands such as the Naval Air Systems Command, Aviation Supply Office, Naval Aviation Depot Norfolk, VA, U.S. Army Material Command and the Naval Supply Systems Command in Washington, DC.

Numerous visits were made to the Naval Aviation Depot in Alameda, CA to observe the complete overhaul process of the engines and to document the feasibility of implementing JIT. The Allison Division of General Motors Corp. located in Indianapolis, IN was also visited to observe the actual manufacturing process of the parts used in the selected engine and to determine the feasibility of establishing the JIT Supplier Relationship.

In an attempt to explore the role that JIT could play in the reworking of aircraft engines, a single engine, the T56, was chosen for the study. Because NADEP Alameda is the only CONUS NADEP for the T56, and the T56 will be competed within DoD for sole rework capacity, it appeared the logical candidate for this study.

The T56 is made up of numerous assemblies with hundreds of parts. To assist in compiling the various parts, the Automated Bill of Materials (ABOM) was utilized to provide a complete listing of parts. The ABOM is a listing that is generated by the Weapon Systems File which compiles the usage history of the various parts of the engine. Rather than analyzing each bolt and washer in the engine, criteria were established to analyze all parts with a unit price greater than $250 and a replacement factor greater than 75%. In other words, are the parts replaced on each subassembly at least 75% of the time? These criteria would provide the higher usage and high dollar items being reworked in hopes of recovering the greatest cost savings. As a result of the above mentioned criteria, 32 parts qualified for the study.

The Partsmaster software program was utilized to provide all of the tangible data available on these parts. Such information included the manufacturer's location, part number, unit price, procurement history and technical characteristics. This provided the basic information for the study. Although the parts were controlled by numerous Inventory Control

Points, the original manufacturer, Allison Gas Turbine Division of GMC in Indianapolis, IN is the source for most of the selected parts.

The 32 parts listed in Appendix A range in price from $249 to $4,390.20. There are nine parts with unit prices greater than $1000.00, 13 parts greater than $500.00, and 12 parts greater than $250. Although there are numerous parts with unit prices less than $250.00, these were not included in this study.

F. ORGANIZATION OF THE STUDY

The following chapters in the thesis will explore the role of Just-In-Time in the Department of Defense and its impact on the various relationships between Supplier and Contractor. Chapter II will provide a brief introduction into the JIT Contracting philosophy and its present application in commercial industry. Chapter III will provide the history and attributes of the T56 engine and the rework process within the Department of the Navy.

Chapter IV will diagram the Just-In-Time Supplier Selection process and compare this process to that presently employed at the Naval Aviation Depot at Alameda, CA. Chapter V will discuss the changes required at NADEP Alameda to implement JIT. Chapter VI will discuss the changes required by Department of Defense Contractors to implement JIT. Chapter VII will provide a summary of the information

developed in the thesis, listing conclusions, recommendations and areas for follow-on research.

II. JUST-IN-TIME CONTRACTING

A. BACKGROUND

Before discussing the criteria of the thesis, it is imperative that the reader understand the background of the Just-In-Time process. The purpose of this chapter is to trace the history of JIT to its present status with an emphasis on the contracting aspects of the process. Examples will be provided to describe how the process works and the successes that have been achieved by many commercial firms. Finally, the impact of JIT on the Department of Defense will be examined by looking at a command that has implemented the process.

The JIT System has evolved from the Japanese industrial complex where its roots were established in the 1950's. During that time frame the Japanese emerged from the post war era with an eye to capitalize on the strengths of their industrial base, ready supply of employees, and a participative work style. [Ref.9:p.9] To fully utilize these strengths, they developed a manufacturing base around mature products that were standardized and able to be assembled and produced in large quantities, e.g., cameras, watches, autos.

In order to be able to compete on the international market however, the Japanese had to look beyond their low cost labor

force to achieve additional cost reductions. [Ref.6:p.8] Both manufacturing and marketing costs had to be reduced on a continuing basis, causing the Japanese industrial planners to focus on the materials procurement and inventory management areas to try to cut the fat. As a result of the search for cost reduction in these areas, Just-In-Time was born.

Just-In-Time is a manufacturing process that focuses on inventory reduction and quality improvement by scheduling the arrival of parts just in time for assembly. The focus is on eliminating waste and making the product correctly the first time. Richard Schonberger, a well known advocate of the process, has described it in this manner:

> Produce and deliver finished goods just in time to be sold, sub-assemblies just in time to be assembled into finished goods, fabricated parts just in time to go into subassemblies, and purchased materials just in time to be transformed into fabricated parts. [Ref.49:p.16]

The initial concept of JIT is to reduce inventory and the costs associated with it. Another facet of JIT that is often overlooked, however, is the improvement of quality in the product as a result of reduced inventories. How this occurs is simple.

When a product is being manufactured in an assembly line process, the workers are not as concerned about the quality of the part if there is excess inventory on the shelf that can replace a part discovered to be defective. If however, the worker knows that his mistake may cause the entire assembly line to shut down, he will be more apt to insure that the part is made correctly the

first time. The major thrust is to promote responsibility and accountability of the individual workers.

Therein lies the beauty of this process. Just-In-Time exposes the inefficiencies in the production process and attacks them with a vengeance. The production process is fine tuned to the point where there is a minimal amount of excess.

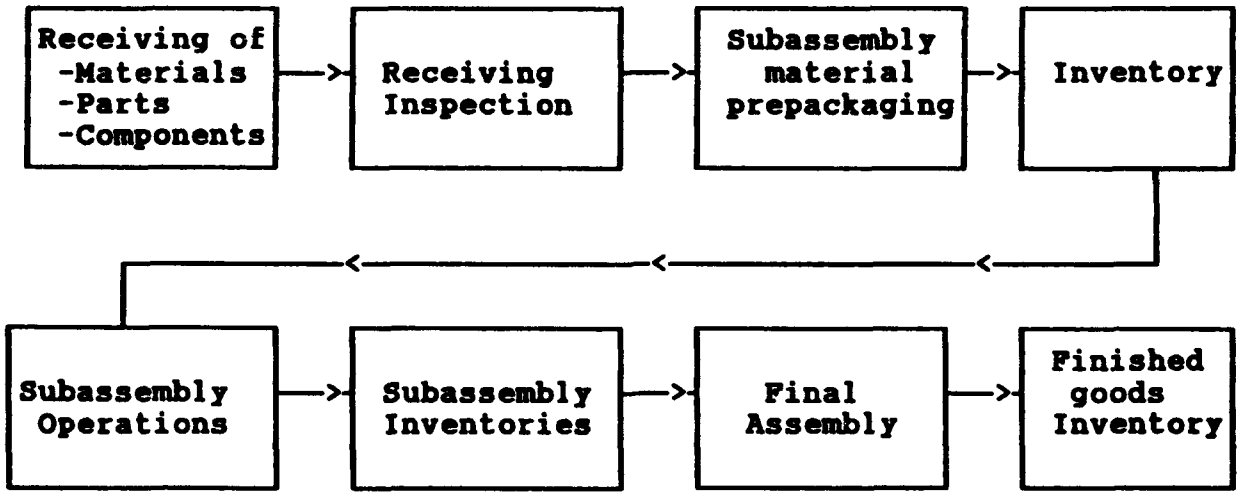
> Hence, in an effective JIT application, the operating policy is to minimize production and work-in-process inventories by providing each work center with just the quantity of materials and components needed to do a given job at the exact time they are needed. [Ref.13:p.433]

Many other areas of the firm must also be fine tuned to properly support the production process. Sales forecasts are no longer a shot in the dark. The forecasts must be accurate to determine the exact quantity to be produced thereby eliminating excess Finished Goods Inventory. Suppliers also need an accurate forecast to gear their production. Inspections are another area in JIT that differ significantly from the conventional form of production. In JIT, the inspection process is the responsibility of the Purchasing and Quality Control departments and is conducted at the Supplier's plant during the Supplier Certification Process, to be discussed later in this chapter. No longer are parts inspected on the delivery dock and put on the shelf. Instead the parts are delivered straight to the Work-In-Process assembly line. An automotive seat maker has perfected this process. [Ref.39:p.74]

In this case the supplier loads the seats onto the delivery truck in the order of utilization on the assembly line. Robots are used to offload the seats at the assembly line where the seat

colors arrive in sequence with the cars being made on the line. Red seats are offloaded from the right side of the truck to be installed in the red Pontiacs rolling down that side of the line. The supplier in this instance is so closely aligned to the manufacturer that if the assembly line of the manufacturer shuts down, the supplier's assembly line will also slow down to prevent any backup. [Ref.39:p.74] A comparison of the conventional and JIT production operations makes it easy to see the benefits of this system. [Ref.13:p.435]

Conventional Operation



Just-In-Time Operation

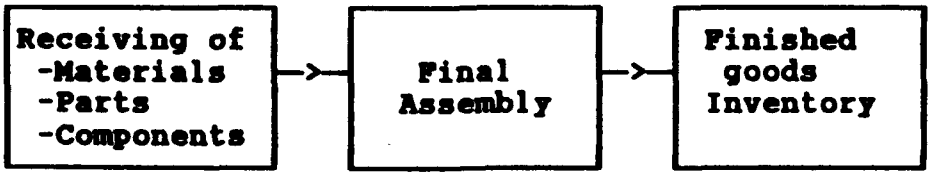


Figure 1, Source: Dobler, Burt and Lee

Although Just-In-Time is a manufacturing process, it has a significant impact on every department of the firm. This is where

the contracting phase of Just-In-Time comes into the process. The Purchasing Department takes on a completely new and more involved role. In JIT Contracting, the Buyer plays a critical role in four important areas: Supplier Certification; Long Term Relationships; Quality Control; and Frequent, Smaller, On-Time Deliveries. [Ref.6:pp.29-38] The Supplier Selection phase will be dealt with separately in Chapter IV.

B. SUPPLIER CERTIFICATION

In JIT, the supplier becomes an extension of the manufacturer and as a result, the buyer plays an integral role in mediating between the parent company and the supplier. [Ref.13:p.437] Most businesses would expect that the ideal situation is to have a variety of suppliers and allow the competitive forces in the marketplace to drive the price down while maintaining a large supplier base. This is the philosophy behind the Government's Competition in Contracting Act of 1984. In JIT however, the idea is to have very few, if not a single, supplier and to establish close ties with them. To many this would seem like an ideal situation for the supplier, and it is. The screening process to become one of these suppliers however, is very stringent. [Ref.19: p.40]

In JIT, the manufacturing requirements are developed by the Engineering, Marketing, and Finance Departments as to what parts are needed and a price that will allow the company to meet its goals. The buyer must take these requirements and find a supplier

whose parts will make the product work. To do this, he must work very closely with the other department to ensure that the parts are available at the right price, in depe'able quantities, and most importantly, of the highest quality. How does the buyer decide which supplier will deliver quality products and not just promise it? Through a Supplier Certification Process. The following Five Phase Process is an example. [Ref.19:p.42]

In this process, the supplier base is reduced to only a few suppliers who have the ability to meet the long term needs of the firm. The three main areas that are considered in this process are: [Ref.19:p.23]

*Objective performance data.
*Long term vitality and financial responsibilities.
*Technical leadership and know how.

With these areas in mind, the buyer asks the following types of questions of his supplier base:

-Where are the suppliers located?
-How many items does each supply?
-What is their quality capability?
-What is the supplier's delivery performance?
-What are their minimum/maximum capacity limits?

By analyzing the supplier base in light of the above questions, the buyer, along with other department representatives, can begin to narrow the field of suppliers to only a few. With a smaller field of potential suppliers, the Supplier Selection Team, (the Buyer, Engineering, Marketing and Finance Representatives), begins an in-depth analysis of the remaining choices. This begins Phase One of the selection process. [Ref.19:pp.56-59]

In Phase One, the company is looking to determine if the supplier's manufacturing process is qualified to meet the requirements. The Selection Team's Engineers will look at the supplier's first batch inspection to develop with the supplier the same standards of expected quality. The team will look at the supplier's reject rate, drawings, specifications, and most importantly, the supplier's inspection process. One of the benefits in JIT production is a reduction in the number of inspections. This reduction is only achieved once the parent firm is convinced that the supplier has a system in place to produce quality parts consistently, similar to the Government's Contractor Risk Assessment Guide, (CRAG), Program. Phase One begins this system analysis which carries over into Phase Two.

Phase Two is an analysis of the production process by the buyer and the team of engineers to evaluate the supplier. A plant visit observing the supplier's production process looks for areas requiring improvement. Statistical Process Control is incorporated and evaluated in this phase to improve efficiency and reduce waste. For example, if two machines are located next to each other, performing identical tasks and operated by workers of similar qualifications, it may be suggested that one worker operate both machines thereby reducing the labor costs by 50%.

Upon completion of this visit, the team's findings are submitted to the supplier in a memo detailing the corrective action needed to achieve certification. If the supplier is unwilling to take the corrective actions listed in the memo, the process is

ended. If he is willing to adjust his manufacturing process, the firm's team of certifiers will work with the supplier to improve his production process and meet certification. This teamwork between the parent firm and its supplier is a pivotal part of the process. The supplier, in a sense, becomes an extension of the firm and it is so important to treat him as such.

Phase Three of the selection process is the finalization stage. In this stage, the supplier implements the system approved by the certifiers and agrees to an evaluation and inspection process in the future. A determination is made of how many lots will be inspected at the supplier's plant and what defect rates are acceptable. Zero defects is the benchmark.

Phases Four and Five are the Certification and On Going Audit Phases. Here the parent firm puts its stamp of approval on the supplier's process and the relationship is born. According to a recent Purchasing Magazine survey, 74% of the firms polled have a certification process for their suppliers. [Ref.40:p.75] The important points to remember are that both firms can expect problems to creep into the system. With a process this demanding, it is expected that there will be numerous problems that arise. Phase Five is similar to the Government's Post Award Conference wherein the parties meet to handle these problems in advance to ensure that the supplier is aware of what is expected.

Once the supplier achieves certification, a certification ceremony is recommended to promote the team concept of the manufacturer and the supplier. The Ford Motor Co., takes out a

full page advertisement in the Wall Street Journal to congratulate its certified suppliers. It is important however, to make clear that the supplier can lose certification and be subjected to the same intense process of Phases One through Four in order to recertify. It is therefore imperative on both parent firm and supplier that the production process be established and upper management committed to the process prior to certification. One of the best methods used to enhance this process is by committing to a long term relationship.

C. LONG TERM RELATIONSHIPS

As previously mentioned, the JIT philosophy requires that the supplier become an extension of the buyer's company. In Japan, most of the employees are hired with the understanding that they will work for the company for the rest of their lives. [Ref.6:p.5] This long term approach is incorporated in the company's selection of suppliers. Once the supplier has passed the rigid demands of the certification process, they can be assured of receiving the buyer's business for a long time.

At the NUMMI plant in Fremont, CA, the 45 vendors currently supplying indirect materials have very little chance of losing the company's business. [Ref.44:p.78] In the past seven years since the plant opened, only two suppliers have been dropped and only after many efforts by NUMMI to help them meet the performance standards. In another case, General Motors spent two years interrogating over 400 potential suppliers for a new engine before

paring the list to 69. Every part is single sourced with only one exception. GM guaranteed that as long as quality and cost are the top priority, the suppliers would get the business for the life of the engine. [Ref.39:p.71]

The long term relationship makes a lot of sense. The Supplier Certification Process is very time consuming and therefore expensive. To try to solicit numerous suppliers only to develop competition is spending that money needlessly. This is where the Government devotes a tremendous amount of its resources and handcuffs its buyers. More time is spent searching out competition and filling out the reams of paperwork to substantiate the numerous sources, in many cases only to achieve minimal savings.

The JIT Certification Process is demanding and hence a strong temptation to short cut the process exists. In this researcher's opinion, however, the long term relationship is the incentive that causes the suppliers to sign up for this program. The trend in industry indicates that many firms are allowing themselves to become an extension of the manufacturing firm. The charts depicted in Figure 2, listing the percentage of long term contracts utilized before and after incorporating JIT, show the trend is in favor of these long term relationships. [Ref.40:p.64]

D. QUALITY CONTROL

Quality is a major outgrowth and goal of JIT. Just-In-Time derives a large part of its quality control requirements from the Total Quality Management literature developed by Dr. W. Edwards

Deming. A part of the Total Quality Control emphasis in JIT is Statistical Process Control. [Ref.13:pp. 392-393.]

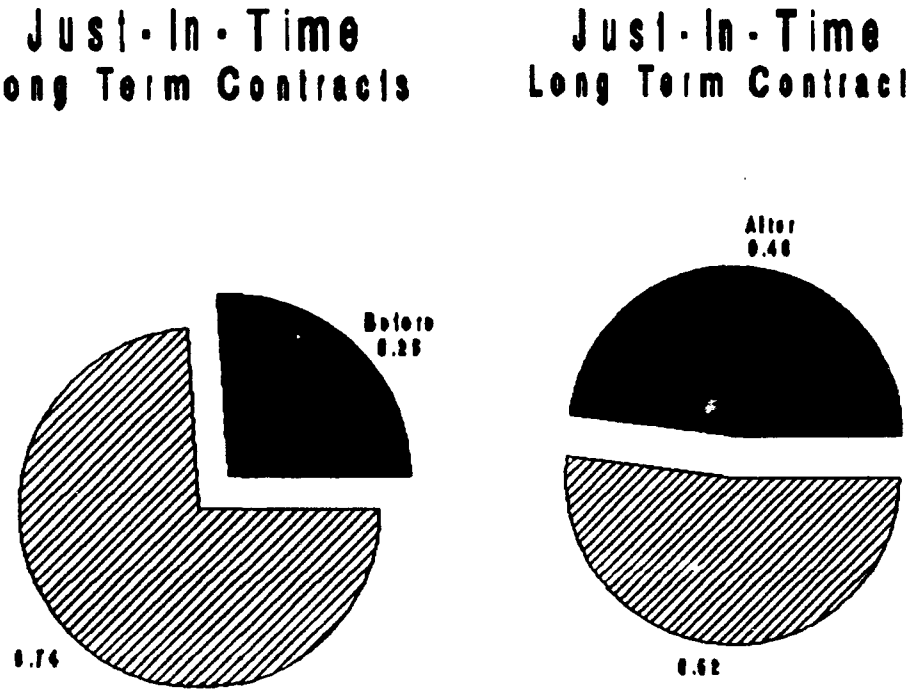


Figure 2, Source: Ernest Raia

Statistical Process Control is a method used to chart the manufacturing process and determine if it is within tolerance. Measurements are taken by Quality Control and Maintenance specialists to determine if the manufacturing process is stable or if there are outside influences changing the process, such as human error, equipment problems, or material variances.

Once the process is determined stable, a series of charts are kept to measure the process and detect any changes. If any changes are detected, the process is stopped immediately and an investigation proceeds into what caused the change. The process

will be stopped even though the equipment is still producing within the tolerance level. Statistical Process Control holds the equipment operator responsible for the process and enables him to detect the problem, make any corrective changes, and continue the process. The result is fewer defective parts and more satisfaction and pride going into that worker's product. [Ref.19:p.72]

As a result of Statistical Process Control, the buyer is able to monitor the supplier's ability to deliver quality goods on a consistent basis. In some cases, the SPC control charts are submitted with each shipment of parts. [Ref.13:p.433] Another monitoring device for many companies is to rate their vendors according to their performance over the past month by tabulating the number of defective parts and reworks. [Ref.46:pp.22] In this manner, the buyer can determine if the vendor's Quality Control programs are in place and functioning properly. This practice of monitoring the process enables the company to avoid the time consuming inspections that are common in many U.S. firms.

E. FREQUENT/SMALLER/ON TIME DELIVERIES

As the name implies, Just-In-Time is geared to reduce inventory levels by having the parts arrive in the order of installation. To achieve this goal, the buyer must establish delivery schedules on a more frequent basis and in smaller lot sizes. The buyer must change the production department's desire to have numerous shelves of excess parts Just-In-Case they are needed. [Ref.40:p.59] This excess is costly to maintain and leads to a

lackadaisical approach to quality production. In this instance, it is no longer imperative that the supplier deliver quality parts because there are always spares on the shelf. With no excess inventory sitting idle, the pressure is increased to ensure that quality parts are arriving on time.

The buyer in JIT contracting is responsible for establishing the transportation schedules. On-time delivery is a major requirement for the supplier to receive the contract. In a recent Purchasing Magazine survey on JIT practices, 92% of the firms polled listed on-time delivery performance as the number one consideration for selecting a supplier. [Ref.40:p.69] No longer are the suppliers given a delivery window of so many days early to so many late. Rather, the tolerance windows are drastically reduced, as both early and late deliveries are unsatisfactory. In addition, many firms are now setting their delivery schedules in hours rather than days.

Although many critics of the JIT process attribute Japan's success to its compact geography, accurate stable schedules can support the frequent delivery requirements even in the U.S. "Milk runs" have been established to provide parts deliveries to the NUMMI plant in Fremont, CA via a network of trucks and railcars from consolidation points in Chicago and Detroit. [Ref.40:p.69] The buyer, as depicted in Figure 3, is also becoming the principal decision maker in selecting which carriers to use. These Carriers are also required to pass the same certification process regarding their ability to deliver on time.

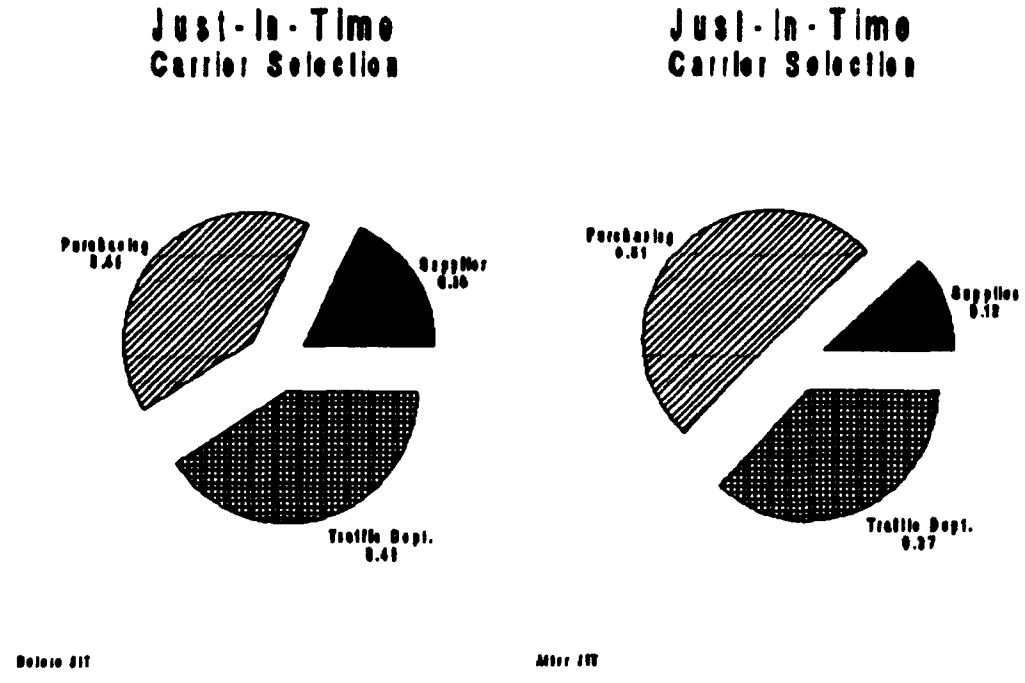


Figure 3, Source: Ernest Raia

The real question with the JIT Contracting process is: Does it work? There are many success stories in JIT, a few of which are listed in Table 1: [Ref.19:pp.9-10]

F. JIT IN THE DEPARTMENT OF DEFENSE

As the above commercial firms have experienced success with the Just-In-Time process, many DoD commands have experienced similar results. One example, the Naval Supply Center, Jacksonville, FL, is listed below:

NSC Jacksonville, FL:

At the Naval Supply Center in Jacksonville, Fl a study was conducted of fast moving, high cube, consumable items where JIT contracts were let for one year. [Ref.55:p.1] The results listed

TABLE 1

Apple Computer, MacIntosh Division:
Inventory turns: 24 per year.
More than 50% suppliers certified.
Vendor base cut by 50%.

Harley Davidson:
Cycle frame process time cut by 70 days
Set up times reduced by 75%.
Productivity up 30%.
Inventory down by $22 million.

Ferro Manufacturing Company:
Productivity up 46%.
Scrap reduced by 67%.
Rework hours cut by 93%.
Total cost of quality down by 47%.

Northern Telecom:
Circuit Board production up 25%.
Component completion/testing time reduced from 160 to only eight hours.
Inventory and Work in Progress cut 81%.
Supplier base reduced from 1000 to 200.

Xerox:
Rejects on out sourced parts reduced from 5000 to 1300 parts per million.

Motorola:
Reduced inventory by 21 million.

General Foods:
Inventory accuracy greater than 90%.
Set up time on manufacturing area reduced by more than 50%.
Compliance to schedule improved 40%.

Kawasaki, Lincoln, Nebraska:
Set up time on punch press reduced from 45 minutes to less than one minute.
Achieved 26 inventory turns per year.
Eliminated set up on final assembly line.

in Table 2 display the success of the JIT contracts as compared to GSA stock prices. Although the price savings are significant, the space saved only multiplies the cost savings.

TABLE 2

Stock Number	Nomenclature	U/I	Contract Price	Stock Price
01-183-9764	Plastic Bags	BX	11.75	31.28
00-162-3006	Paper Cups	BX	32.25	37.33
00-285-7001	Napkins, pap	BX	20.92	38.87

In addition to consumables, NSC Jacksonville has also contracted for gas cylinders under JIT. Under this system the contractor holds cylinders for a fee and issues full cylinders direct to customers. The contractor is responsible for purging and cleaning of empties while NSC conducts required inventories and inspections at the contractor's site. Requisitions are received and the orders placed by NSC storage personnel directly to the contractor. The Supply Center anticipates annual savings of $39,510 in handling costs alone. [Refs.24/25:p.1-3]

The success of the Just-In-Time program at NSC Jacksonville has caused many commands to analyze their program to determine if the process can work for them. Most all of the Material Commands within DoD are utilizing some form of inventory reduction process, though it may not always be JIT. As a result of the Defense Management Review however, each Service is searching for any method of reducing costs and still maintaining combat readiness and support. Just-In-Time may be the best solution to today's budget reductions.

G. SUMMARY

Just-In-Time is a revolutionary new way of thinking about production that has completely turned around a country's Industrial Complex. The application of this process in the contracting arena provides tremendous challenges for the buyer in his relationship to his own company as well as his suppliers. The track record of JIT in many U.S. companies has provided an impressive list of success stories. The Department of the Navy has also experienced success and the future is ripe with many more opportunities for implementation.

Now that the background has been developed, the feasibility of implementing the Just-In-Time system in one specific area of the Department of the Defense can be explored. Rather than looking at JIT from an inventory approach, the study will examine its application to a production process. Chapter III begins this exploration by looking at the process of reworking the T56 aircraft engine at Alameda, CA.

III. THE T56 ENGINE

A. INTRODUCTION

The Just-In-Time method achieves the greatest results from a continuous flow production process. [Ref.49:p.21] Many auto, camera, television and computer companies have implemented this process and achieved stunning results. The question therefore arises: Where in the Department of Defense is there a production process that could experience significant cost savings by implementing JIT? The reworking of aircraft engines at the various Naval Aviation Depots (NADEP) is one of the few production processes that could have some application for JIT.

The purpose of this chapter is to introduce the reader to the selected engine, the T56. A brief history of the engine will be provided as well as the present applications of the engine, both commercial and military. In addition to introducing the T56, this chapter will diagram the rework process of the T56 engine and identify and discuss the mission of the various players involved in reworking the T56.

The NADEP at Alameda, CA was chosen as the test site for research into the feasibility of JIT due to its close proximity and the workload that this location supports. NADEP Alameda is the rework facility for numerous military aircraft

engines. One engine in particular stood out as the most likely candidate to implement the process, the T56. The reworking of the T56 engine was recently consolidated within the Department of the Navy at NADEP Alameda after the maintenance process at NADEP Norfolk, VA was discontinued. This, along with the fact that NADEP Alameda is seeking methods to improve their production process with some form of the JIT method, made the T56 at Alameda the logical choice.

B. BRIEF HISTORY OF THE T56 ENGINE

1. DEVELOPMENT OF THE T56

The T56, considered by many to be one of the great success stories of American Aviation history, is a turboprop engine manufactured by the Allison Gas Turbine Division of General Motors Corporation located at Indianapolis, IN. The engines were initially named the YT engines during flight test and were delivered to Lockheed in 1953. There have been four generations of the T56 beginning in 1954 with Series I. Series II was produced beginning in 1958, Series III in 1964 and the latest, Series IV, in 1987. Since the initial production, Allison has produced over 15,000 T56 engines which have accumulated over 136 million flight hours. [Ref.15]

The initial T56 production went into the C-130 aircraft produced by Lockheed. Since its initial production, the T56 has been used in the C-130 aircraft utilized by all military services, as well as 62 countries around the world.

Although the Series I and II engines are no longer in production, the Series III is still in production today; principally for the C-130, the P-3 and Foreign Military Sales (FMS) of the E-2 aircraft.

The development of the Series IV engine was initiated under the U.S. Air Force Engine Model Derivative Program (EMDP) in the late 1970's. Though an Air Force requirement did not immerge, a Navy requirement for the E-2 did. This came about when the Navy discovered that the E-2C, with the weight of additional avionics, had a negative rate of climb with one engine out. The Navy picked up that development and took it into production with initial deliveries in 1987.

The Series IV engine is rated at 5950 shaft horsepower at takeoff with a specific fuel consumption of .42. When compared to the original Series I engine, takeoff shaft horsepower of the Series IV engine has increased 72% while specific fuel consumption has improved 19%. Figure 4 displays the increases in power and improvements in fuel consumption achieved by each successive series of T56 engine. [Ref.15]

While peak annual production exceeded 700 engines a year in the early 1960s, recent production rates are in the order of 200 engines per year. Allison expects this rate to continue for the near future and that T56 powered aircraft will continue to operate in significant numbers well into the twenty-first century. [Ref.15]

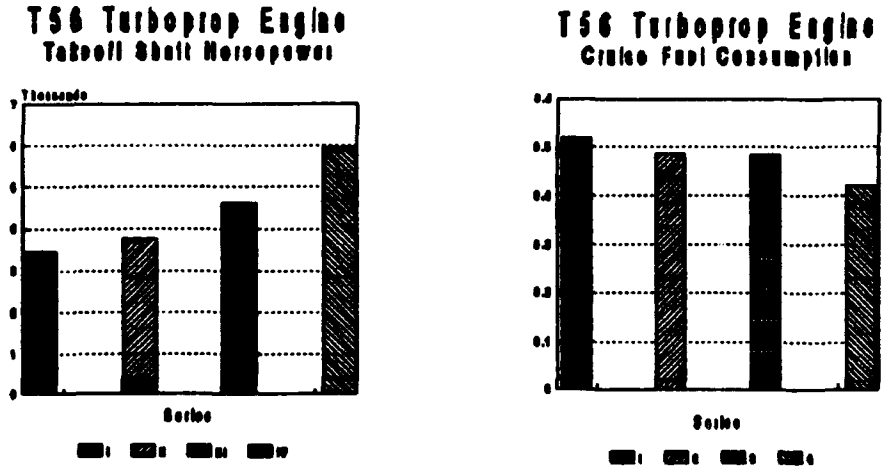


Figure 4:Allison Gas Turbine Division

2. T56 PRESENT APPLICATIONS

The T56 is presently installed in many U.S. Navy, Air Force, Marine Corps, Coast Guard, and Foreign Military aircraft. The U.S. Navy and Marine Corps presently use the T56 in the P-3 patrol plane, the E-2 Hawkeye Early Warning plane and the C-2 and C-130 cargo planes. There are currently four series and nine models of the T56 engine. A breakdown of the various aircraft installations is listed in Table 3: [Ref.4]

With the history and present applications of the T56 established, the rework process within the Department of the Navy (DON) will be explored.

TABLE 3

T56/501 Production Deliveries		
Series	Engine Models	Aircraft Installations
I	T56-A-1/9A	USAF/C-130A
II	T56-A-7/7A	USAF/C-130B/E
II	T56-A-7/7A	USN/C-130B
II	T56-A-8/426	USN/E-2A
II	T56-A-10W	USN/P-3A
III	T56-A-14	USN/P-3B/C
III	T56-A-15	USAF/C-130
III	T56-A-16	USN/C-130
III	T56-A-422	USN/E-2B/C-2

Source: Allison Gas Turbine Division

C. THE REWORK PROCESS

1. THE OPERATIONAL LEVEL

The Department of the Navy has established the repair and rework of aircraft engines in a series of levels of maintenance repair capabilities. The lowest level is the Operational level where various Squadron maintenance technicians perform preventative and minor corrective maintenance on the engines within their squadron. If the repair work is too difficult for the technicians or requires machinery not available at the Squadron level, the engine is containerized and shipped to the Intermediate level. In some cases the engine can be broken down into subassemblies and

only the defective subassembly will be shipped to the Intermediate level. [Ref.17]

2. THE INTERMEDIATE LEVEL

The Intermediate level is known as the Aviation Intermediate Maintenance Depot (AIMD). The AIMD is the aircraft version of the Shore Intermediate Maintenance Availability (SIMA) for ships. At this level, the repair facilities are larger and the technicians are able to perform the more complicated maintenance actions that the Squadrons are unable due to various constraints. AIMDs are located at most of the larger Naval Air Stations across the country. Work that the AIMD is unable to perform will be shipped to the next highest level, the NADEP. [Ref.17]

3. THE DEPOT LEVEL

The Naval Aviation Depot is the highest level of repair facilities available. The Depot is able to perform any maintenance action, including all of the tasks performed at the AIMD and the squadrons. There are six NADEPs in the United States located at NAS Alameda, CA; NAS Norfolk, VA; NAS Cherry Point, NC; NAS Jacksonville, FL; NAS Pensacola, FL; and Naval Air Station North Island, CA. [Ref.45] A flow diagram of these three levels is presented in Figure 5.

Upon arrival at the NADEP, the engine is removed from its container and sent to the Examination and Evaluation (E&E) section of the facility. Here the technicians determine what

T56 REWORK PROCESS

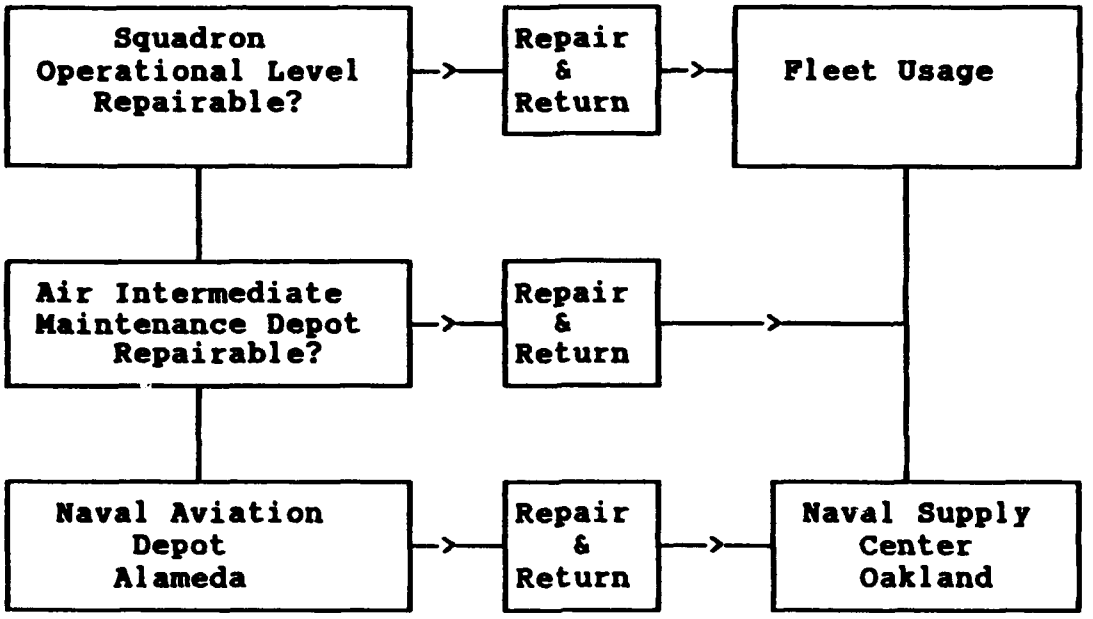


Figure 5

is wrong with the engine, and what is required to make the engine operational. The engine is broken down into subassemblies and routed to the various stations within the NADEP for maintenance work. A brief example using the repair of the engine's compressor will demonstrate this process. [Ref.35]

In the case of the engine's compressor, the inlet case, rotor assembly and bearings will all be separated and routed for cleaning, blasting and zyglo, (a method of checking for hairline cracks in the steel). The technicians will examine the components for dimensional requirements, corrosion, nicks, dents, scratches and will repair or replace the studs. After the examination, they will pressure test,

refinish internal and external surfaces by welding, machining, metalizing, releading seals and painting. The subassembly is then consolidated for reassembly, containerized and returned to the nearest Supply Center, NSC Oakland in this case, for induction into the supply system. At the NADEP at Alameda, this process takes approximately 47 days for major repairs.

D. THE PLAYERS IN THE PROCESS

1. ORGANIZATIONS

There are numerous players in the rework process for the T56 engine. Each player fulfills a separate role in support of the fleet requirements for the engine. The major players however, whose roles will impact this study, include the Naval Air Systems Command (NAVAIR), the Naval Aviation Depot Operation Center (NADOC), the Aviation Supply Office (ASO), the Naval Aviation Depot at Alameda, CA, the Naval Supply Center at Oakland, CA and the Allison Gas Turbine Division of General Motors at Indianapolis, IN.

2. NAVAL AIR SYSTEMS COMMAND

The Naval Air Systems Command, located in Washington, DC, is the senior command in the process that houses the T56 Program Office and controls the funding for the engine. [Ref.17] NAVAIR also provides engineering and logistics management for both the fleet support as well as the shop support, such as the one at Alameda. In addition, NAVAIR has engineers on location at Alameda monitoring the production

process, and the performance of various parts used in the T56. If the NADEP is experiencing a high failure rate on a certain part, NAVAIR engineers will investigate the situation and report their findings to NAVAIR headquarters in Washington, DC. One of the commands under NAVAIR is the NADOC.

3. NAVAL AVIATION DEPOT OPERATING CENTER

The Naval Aviation Depot Operating Center, located in Patuxant River, MD, is the authority for scheduling of the T56 rework. [Ref.17] The NADOC determines the flow of the engines to the Depot due to fleet usage. By analyzing the number of T56 flying hours from the various squadrons, they provide the NADEP with a production quota per quarter to meet forecasted operational commitments.

4. NAVAL AVIATION DEPOT, ALAMEDA, CA

The Naval Aviation Depot will take the production quota from NADOC and a scheduler will subdivide the quarterly requirements into a weekly schedule. This weekly schedule is distributed to the various rework stations to insure timely completion of requirements. Table 4 is a sample of a quarterly schedule broken down into the engines' three major sections: power, gearbox and torquemeter: [Ref.35]

The table lists a cumulative schedule that provides a running total to let the Depot know where they stand in relation to the schedule. The various workstations

TABLE 4

T56 ENGINE QUICK LOOK SCHEDULE			
	POWER	GEARBOX	TORQUEMETER
Total Required	29	45	49
Schedule:			
04/05	1	3	4
04/12	2	7	8
04/19	4	11	12
04/26	6	14	16
05/03	8	18	20
05/10	10	22	24
05/17	13	26	28
05/24	16	30	32
05/31(4 days)	18	33	36

Source: Naval Aviation Depot, Alameda, CA.

submit their parts requisitions through the Supply Department to the Naval Supply Center nearby in Oakland.

5. **NAVAL SUPPLY CENTER, OAKLAND, CA.**

NSC Oakland is the NADEP's requisitioning authority whose mission is to insure the parts are in house in time to support the rework schedule listed above. [Ref.10] Upon receipt of the parts requisitions, NSC Oakland inputs these requirements into the Supply System and transmits them to the cognizant Item Manager. The Department of Defense (DoD) supply system is set up in the form of a commodities support system wherein various Item Managers procure specific

commodities instead of the full range of parts required. For instance, the Defense Electronics Supply Center (DESC) in Dayton, OH procures only electronics items for DoD. The Defense Industrial Supply Center (DISC) in Philadelphia, PA procures only industrial supplies.

The Supply Center passes these requirements to the various Item Managers for support. In the case of the T56 engine, the majority of the parts selected for this study were stored at the locations in Table 5 denoted by the command's COG. (The COG is a Navy code designating the cognizant item manager for each part). [Ref.12:pp.42-43]

6. AVIATION SUPPLY OFFICE

One of the Item Managers listed above who plays a significant role in the T56 rework process is the Aviation Supply Office (ASO) in Philadelphia, PA. [Ref.17] In addition to being the Item Manager for the 1R/7R cog items, ASO is also involved in the forecasting of requirements and monitoring the repairables program for the T56. The 1R/7R cog items are major components of the engine and require extensive lead times to procure. As a result, ASO monitors the NADEP's workload and predicts the upcoming requirements based upon historical data. ASO also monitors the T56 Depot Level Repairable (DLR) program. The DLR program requires fleet commands to turn in failed parts or carcasses to the NADEP

TABLE 5

COG	ITEM MANAGER
1H	Navy Ship's Parts Control Center, Mechanicsburg, PA
1R/7R	Navy Aviation Supply Office, Philadelphia, PA
9C	Defense Construction Supply Center, Columbus, OH
9E	Aviation Systems Command (Army) St. Louis, MO
9N	Defense Electronics Supply Center, Dayton, OH
9V	Navy Fleet Material Supply Office, San Antonio Air Logistics Center, Kelly AFB, San Antonio, TX
9Z	Defense Industrial Supply Center, Philadelphia, PA

for repair and return to the system. Frequently, the cost of repairing the old carcass is much cheaper than purchasing a brand new part. These DLR's tend to be the larger and more expensive components of the engine. In order to support the fleet with the required numbers of these high dollar value items, ASO works closely with the last significant player in this process, the manufacturer.

7. ALLISON GAS TURBINE DIVISION

The manufacturer for the T56 engine is the Allison Gas Turbine Division (AGTD) of General Motors located in Indianapolis, IN. The military sales division of Allison receives the requirement from ASO and, after negotiating the

price and delivery schedule, inputs the requirement into their Technical Division. The Technical Division verifies the Part number and determines if it is on the Critical Parts List (CPL) in order to insure availability for other customers. The requirement is then sent to the Packaging, Handling, Support and Transportability (P,H,S,T) section to determine the packaging and handling requirements. [Ref.11]

The next stop is the Business Financial Planners (BFP). In one area of the BFP, the Financial experts determine the price based on inputs from the previous technical areas and required lead times to procure or produce the part. This information is then passed back to the Service Parts section. The other section of the BFP is the Program Administrative section. Here the make-or-buy determination for each item is made. A flow diagram depicting this process is presented in Figure 6. [Ref.11]

If Allison is to buy the item, a vendor will be located and price and delivery schedules will be verified. If the item is to be manufactured by Allison, the request goes to the production areawhere the applicable specifications and inspections are incorporated into the process. Once manufactured, the item is sent to the Finished Goods Inventory. If the part is purchased however, it comes directly into the Receiving Department. From each of these locations, Finished Goods or Receiving, the part is then sent to the packaging and subsequent sections.

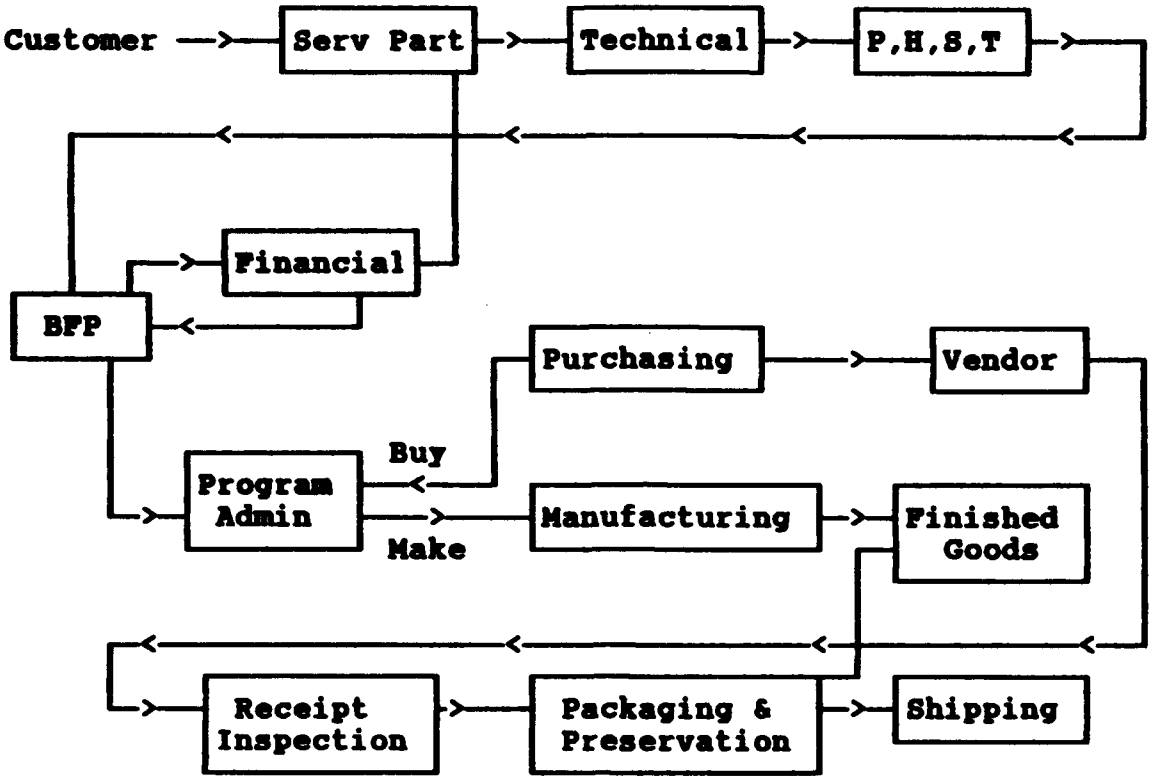


Figure 6, Source: Mr. Tim McGrath, Allison Gas Turbine Division.

In addition to the production facilities in Indianapolis, Allison Gas Turbines has a worldwide network of distributors and authorized maintenance/overhaul centers. The distributors work through three sponsors, Aviall Inc., National Airmotive Corp. and Standard Aero Limited. Through this network, Allison is able to provide support and overhaul capabilities in such countries as Japan, Peru, Korea, Singapore, Brazil, Greece, Italy, England, Portugal and France. This network was especially helpful in providing overhaul facilities and parts distributors during Operation Desert Storm. [Ref.4:pp.43-46]

E. SUMMARY

The rework of the T56 engine provides an exciting opportunity to apply the Just-In-Time process. The successes of so many commercial firms provide great hope that cost savings and quality improvement will be achieved in the Department of Defense as well. The T56 engine is one of the modern technological success stories with a vast history of service. With its varied applications throughout its history, the T56 engine has played a significant role in the aviation history of the Department of Defense. The rework process of the T56 Engine within the Department of the Navy involves many players working in unison to ensure the desired number of engines are available within the system to meet fleet requirements. The manufacturer of the T56 engine, Allison Gas Turbine, is a supplier of quality material and possesses a wealth of knowledge on the capabilities of this engine.

Allison Gas Turbine is the original manufacturer and primary supplier for most of the parts of the T56 engine. There have recently been numerous instances where other suppliers are competing with Allison for the support of various parts to the T56. What is the best way to determine who should get these contracts? What do the JIT firms look for in selecting a supplier for their line of parts?

The next chapter "Supplier Selection for the T56", explores the role of dual sourcing and single sourcing of suppliers for this engine. The pure Just-In-Time method of

supplier selection will be compared with the present supplier selection process at NADEP Alameda for a select number of engine parts. It is hoped that in comparing the two processes, possible improvements in the way DoD procures parts to rework the T56 will be discovered.

IV. SUPPLIER SELECTION FOR THE T56

A. INTRODUCTION

Now that the reader has become familiar with the concept of Just-In-Time contracting and the rework process of the T56 engine, the Supplier Selection process will be explored. The Supplier is one of the most important players in determining the success of JIT and the Supplier Selection process is designed to choose those suppliers that will contribute to the growth of the JIT company. This chapter will provide a background on this subject and analyze the attributes that DoD should look for in selecting a supplier for the T56 engine.

B. BACKGROUND

In any industry, the supplier can make or break the company trying to compete for greater market share. As a result, many firms acquire numerous suppliers to ensure that they will have parts support in the event of a default of one of their suppliers. The problems with this scenario are numerous. First of all, the communications between a company and its suppliers is made more difficult because of the number of individuals involved. In the event of a design change for the part, the company's buyer must ensure that each company receives exactly the same information. There is a great danger in this because critical information developed by the

design engineer and passed through the buyer to the various suppliers often gets changed.

Another problem with numerous suppliers for the same parts is the inability of the buyer to monitor each of the suppliers' production processes. As discussed in Chapter II, the supplier Certification process is thorough and demanding. To duplicate this process between the various suppliers requires a significant amount of additional energy. All suppliers will not be treated equally, and their loyalty will go with the company that provides them with the most business. To alleviate this additional workload, JIT buyers use a supplier selection process to enable them to determine who they will establish the long range relationship with.

C. JUST-IN-TIME SUPPLIER SELECTION PROCESS

The Just-In-Time Supplier Selection process attempts to avoid unnecessary duplication by choosing a supplier that will enable the two companies to enter a "Partnering" relationship. [Ref.41:p.50] As previously described, this relationship is a commitment by the supplier to provide quality products on time in return for a long-term commitment on the buyer's part for future business. What do the JIT firms look for in a supplier? According to a recent survey in Purchasing Magazine, the following items identified in Figure 7 were rated most important in Supplier Selection. [Ref.40:p.69]

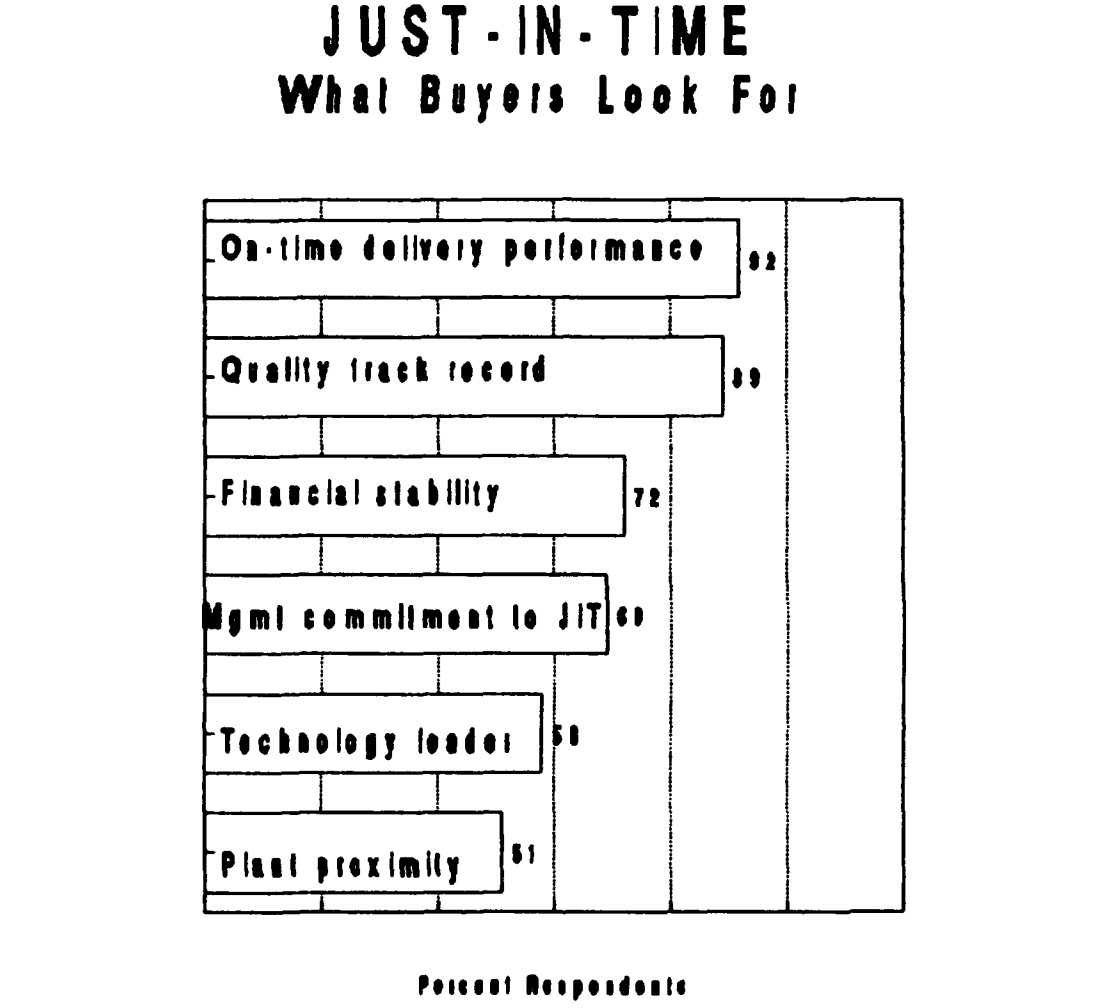


Figure 7, Source: Ernest Raia

1. **ON-TIME DELIVERY PERFORMANCE**

The Just-In-Time philosophy is multi-faceted and requires the elimination of waste in many areas of the

company. The most notable waste is that of excess inventory. In order to combat excess inventory, the JIT company must be able to align itself with a supplier that can ensure the required parts will arrive on time and in the sequence needed. It is not alarming, therefore, that 92% of the respondents to the above poll listed this area as the most important criteria for selecting a supplier.

In a continuous flow production process, many companies are reducing their delivery schedules down from monthly to weekly to daily and, in some cases, down to an hourly basis. [Ref.42:p.69] By aligning with a single, or very few suppliers, the JIT company is able to communicate its requirements better and the suppliers are able to focus on the needs of their major customers. Assembly lines in many plants are monitored by the supplier's assembly process. When one slows down, the other follows in turn. [Ref.39:p.76] This fine tuning of production processes is vital for the success of JIT. It allows the flexibility for both parties to change their processes rapidly. In today's ever changing environment this is a critical attribute for success.

2. **QUALITY TRACK RECORD**

The most often overlooked characteristic of the Just-In-Time philosophy is the continuous improvement in building quality into the product. This not only includes making the part correctly, it also incorporates the Value Engineering

process of improving the part to perform its intended function at the lowest cost. [Ref.13:p.560] Quality in JIT goes hand in hand with the reliability of the product and the supplier that provides the product. Because of the single source approach to procurement, the JIT company is putting a lot of trust in the selected supplier. This requirement for producing a quality product is not just a one time event, but an emphasis on continually improving the quality of this part over time. Many companies are tempted to cut costs by changing their production process in a manner that will not significantly affect the product's performance. Invariably this shortcut shows up as a recall of the product and an outlay of additional money coupled with a decline in the company's goodwill. It is interesting to note that low price is not even listed in the survey as a criteria that buyers look for in selecting a supplier.

Because of the emphasis on quality, many JIT companies look at the long range effect of the relationship with a supplier instead of the initial cost of the item. In so doing, these companies avoid competitors buying into the contract as the low bidder, yet being unable to deliver quality at that price. In addition, companies continuously subjected to emphasizing price competition in the supplier selection process, will be pulling present suppliers off of their learning curves only to have a new supplier undergo the same problems. [Ref.49:p.176]

3. FINANCIAL STABILITY

The 1980's was a decade that brought tremendous profits to many industries, especially the Defense industry. Unfortunately for many companies, it was also a time of accumulating unprecedented debt. Last year a Fortune magazine article entitled, "Hard Lessons from the Debt Decade", reported that the debt ratio of the average U.S. nonfinancial company had risen from 34 percent in 1980 to 48 percent in 1990. The article stated that it was not uncommon for debt ratios to rise as high as 90 percent in leveraged buyouts. [Ref.8:p.445] In addition to the highly successful firms were a record number of companies that declared bankruptcy, seeking protection from their creditors.

In looking at various possible suppliers, JIT companies are searching for a partnering relationship whereby the two companies can grow together. If a potential supplier is leveraged to an excessive degree, that supplier will not be able to expand with the JIT company and will restrict their ventures into other markets. In addition, the unit price of that supplier's product will have to shoulder some of the cost of capital used to finance the supplier's debt structure.

At the NUMMI plant in Fremont, CA, the company's buyers are required to go into each supplier's plant at least once a year to analyze the supplier's operation. The continuous improvement in JIT does not focus solely on the production and inventory areas. One area that the supplier

must divulge to the buyer is the financial operation of the company. With an eye bent on improving every area of the supplier that could provide them a competitive advantage, the NUMMI buyer will not hesitate to scrutinize the financial aspects of their suppliers. [Ref.44:p.79]

4. MANAGEMENT COMMITMENT TO JIT

As with any new program, the success or failure of the program depends to a large degree on the support that program has from upper management. JIT is no exception. Without complete commitment from upper management, a company will not be able to push through the difficult implementation periods. Although JIT is a more efficient production process, there is very little room for error. In the production process, a worker who doesn't produce a part according to specifications, insures that the next worker's part will also be out of alignment. It takes top management to stress the importance of monitoring the process and motivating each worker to build in quality.

In a recent survey that analyzed the implementation problems involved with Just-In-Time, 48% of the firms polled indicated that the failure of JIT was due to the lack of upper management support. [Ref.5:p. 13] The survey lists two possible reasons why top management is reluctant to support JIT. The first reason is that most present day managers are more concerned with pleasing their stockholders and insuring

the short term stock values of the company are high. To implement such a radical change as JIT requires long term planning and patience. Customer satisfaction may dip slightly as deliveries arrive late until the bugs are worked out of the system. The pressure from stockholders may cause some managers to forego the implementation of JIT in order to avoid these problems.

The second reason given for management's lack of support for JIT stems from a skeptical view held by many Americans that JIT is a cultural change and that it is not well suited for America's way of doing business. If upper management is not willing to commit itself to JIT, the company will never be able to get over the difficult implementation phases. Northern Telecom has attributed its great success with JIT to "clear champions" in middle management who really believed in the concept and motivated other supervisors to the same degree. [Ref.23:p.6F]

The architect of the Total Quality Management revolution in industry today, Dr. W. Edwards Deming, has published 14 points for implementing TQM. The second point listed is for every worker to learn the new philosophy of TQM top down. [Ref.19:p.60] That implies that upper management is to learn the process first, and teach the middle managers, who, in turn, teach the supervisors, etc. JIT is built around the Total Quality Management philosophy of continuous

improvement and it is essential for upper management to initiate the new process or it will never work.

5. **TECHNOLOGY LEADER**

The next requirement that JIT buyers look for is a future long term supplier that is a leader in the technology of his field. Although this factor is not critical, 58% of the buyers listed this factor as an area that they looked for in selecting the supplier. It stands to reason that if a supplier is a technology leader, his firm is growing and willing to look for new and better ways to improve its business. The JIT buyer will not only be able to gain an efficient supplier with the latest production methods, he will also gain advice on ways to change his present production methods. Many good buyers will admit that the supplier often has a better insight into the buyer's product than any other person. [Ref.21:p.10]

6. **PLANT PROXIMITY**

The reduction in Work-In-Process inventory called for in Just-In-Time requires a firm to fine tune its delivery schedules to an hourly basis in some cases. Many firms have established the JIT relationship with only local suppliers because they feel that greater flexibility can be achieved with a local supplier. Fifty One percent of the respondents to the Purchasing poll believed that close proximity of the supplier to the JIT plant was essential to the success of the

JIT process. This closeness is characteristic of the JIT process in Japan where the suppliers are usually located a short distance between the equipment manufacturers.

The Honda Motor Company has followed this trend in the United States with over 75% of its suppliers located within 150 miles of its Marysville, Ohio plant. All of General Motors' suppliers to its Buick City are located within 300 miles of Flint, MI, or within striking distance of one shift (i.e. eight hours). [Ref.40:p.69]

The tremendous transportation system within the U.S. however, allows many firms the ability to enlist suppliers that are not located close to the manufacturing plant. The NUMMI plant in Fremont, CA, a joint venture between Toyota and General Motors, has implemented a Mid-west orderly pickup system to deliver parts from its Midwest suppliers. Ten trucks begin a milk run each day picking up parts from suppliers and delivering them to consolidation points in Chicago and Detroit. The parts are loaded on a flatbed train and arrive at the Fremont within four days. The transportation system enables more suppliers to compete for JIT business in any part of the U.S. [Ref.42:p.75]

D. SUPPLIER SELECTION FOR THE T56

The Supplier Selection Process for the T56 engine requires the use of the above measurements in determining who will win the various contracts. Because of the DoD Supply System

utilizing various Inventory Control Points, the customer is not closely aligned to the supplier in many cases. As previously described, the NADEP will often require a part from a supplier located completely across country. The request is handled by two or three commands established as go betweens who will take the request and attempt to process it. The Inventory Control Points will often not have the time or manpower to investigate the quality, financial condition or management commitment of the supplier to the JIT process. Instead, the ICP will often select the supplier that is able to provide the part at a reasonable, often the lowest, price.

The engineers at the NADEP know what part they need and would be excellent sources of reference for determining the capability of the competing suppliers for their parts. Unfortunately, the only source of input that these engineers can rely on is a sometimes poorly written statement of work describing the part and its attributes. Because of the nature of the rework process, where the requirements are not known until the engine is opened up, many of the parts are needed expeditiously. As a result, the ability to explore various suppliers for a possible JIT partnering relationship, is negated by the urgency to get the part from any supplier as fast as possible. In many instances, this results in additional requirements to the original manufacturer, Allison Gas Turbines.

E. SUMMARY

The Supplier Selection process is arguably one of the most important steps required to implement a successful Just-In-Time program in any company. Without dependable suppliers, the JIT company will be unable to reduce its on hand inventories to the extremely low levels necessary to reap the cost savings. When looking to align itself with a dependable supplier, the JIT company must invest a considerable amount of time up front looking at many aspects of the way the supplier runs his company. On time deliveries, a quality track record, financial stability, management commitment to JIT, a leader in technology and a location in close proximity to the JIT plant are only a few of the many factors that are reviewed in the selection process.

The Supplier Selection process previously described assumes that a competitive market exists with many suppliers capable of vying for the position of single supplier of a given product to the JIT firm. With regards to the rework process of the T56 engine, this is not the case. As mentioned in Chapter III, the Allison Gas Turbine Division of General Motors Corp., is the sole source and original manufacturer for most of the selected parts. As a result, the Government has lacked the required leverage to change Allison's manufacturing process. Chapters V and VI will explore the required changes needed in both the NADEP at Alameda, and the manufacturing plant at Allison to enable the Just-In-Time process to work.

V. IMPLEMENTING JUST-IN-TIME AT NAVAL AVIATION DEPOT, ALAMEDA

A. INTRODUCTION

The Just-In-Time process has been utilized in many types of industries with stunning results in many cases. The decision to implement JIT however, is a major decision for any company and requires forethought and preparation. As discussed earlier, many view JIT as a cultural change and will resist its implementation for fear of job loss or just an unwillingness to change. Top management must set the stage early with all of the levels of management and supervisors to explain the process and prepare the workforce for the ensuing growing pains.

The requirements of implementing Just-In-Time in the Government is made even more difficult because of numerous factors. The sheer size of the Government with its levels of controls in the Congress as well as the Department of Defense provides a very inflexible structure that resists change. As a result, a practical view of implementing JIT will have to focus on a gradual implementation that can demonstrate success at various stages, thereby garnering support for further applications.

There are numerous impediments to implementing JIT in the rework process at the NADEP Alameda, CA. Many of the

impediments are internal and require an overhaul of the rework process at the NADEP itself. Some of the impediments however, are external to the NADEP and require changes in the "Supply System" described in Chapter III. Both areas will be explored in this chapter. JIT is a drastic change from the way we presently do business in the rework of the T56 engine, but there has never been a better time to institute change than the present. With the implementation of the Defense Management Review (DMR), the Department of Defense is looking for ways to function more efficiently. The time is ripe for taking a good look at the feasibility of using JIT within DoD.

B. BACKGROUND

Before developing the various requirements needed to implement JIT at the NADEP, Alameda it is important to reiterate the scope of this study. Chapter I described the selection process used to determine the 32 parts listed in Appendix A. During the course of researching the information for this study, there were numerous other parts that would be equally feasible to use in applying this process. In the interest of keeping the research at a workable level however, those parts have not been included. Nevertheless, they are an excellent source for follow on research.

The assumption underlying the rework process is that the 32 parts listed in Appendix A would all be replaced 100% of the time. Although the percentages listed in the Automated

Bill of Materials (ABOM) were not always 100%, for the purposes of this study, the assumption is that all of these parts will be replaced every time an engine arrives for rework. This may not appear to be cost effective on the surface. However, this assumption will attempt to modify the rework process and thereby align it more closely to a continual flow manufacturing process. A Cost/Benefit analysis could be performed in the future to determine the feasibility of this assumption.

C. REQUIRED CHANGES AT NADEP, ALAMEDA

1. THE EVALUATION PROCESS

The NADEP at Alameda is set up on a shop type basis where the T56 engines arrive and are first sent to the Examination and Evaluation (E&E) area where the inspectors open up the engine and determine what work will be performed. This cursory inspection itself is very subjective and there are many factors that impact this inspection.

The T56 engine is used in many different aircraft and in many different environments. A C-130 aircraft utilized for moving cargo from various installations within the Continental United States (CONUS) will probably have a longer mean time between failure (MTBF) than a P-3 aircraft constantly exposed to the salt air environment while monitoring an area off the coast. Many of the T56 engines used on aircraft in support of Operation Desert Storm experienced greater than normal wear on

various parts of the engine due to exposure to the high temperatures and sandy conditions of the Arabian Gulf region. The environment within which the T56 engine is used will often determine the rework required.

There is an element of subjectivity in the E&E stage. [Ref.8] There are some inspectors who will try to minimize the amount of work required to be performed on the engine. They will look at the environment the engine was operating in, the number of hours the engine has been flown and make a determination of exactly what parts need to be reworked. Utilizing the old adage, "If its not broken, don't fix it", this type of inspector will separate out only those parts needing rework in his opinion. As a result, he will minimize the amount of work being sent to the various shops for rework.

Another inspector may take a more cautious approach. If the engine has a considerable number of hours and was used in a difficult environment, this inspector may choose to remove more parts for repair and rework. Although many of these parts are technically operable, they may be reworked in an attempt to reduce the possibility of failure. As a result, this inspector will extend the time the engine remains in the rework process. The long run view, however is that once the engine has completed this process, it will remain in service in the fleet for a longer period of time.

The subjective nature of the examination and evaluation process needs to be reduced. The process must be

controlled so that an engine coming out of rework will be in a similar condition to any other T56 engine coming out of the process. By always replacing the 32 parts used in this study the inspectors will instill greater consistency in the reworking of the T56 engine and reduce the subjectivity of the evaluation process.

2. THE FORECASTING PROCESS

Forecasting the workload at the NADEPs has been a difficult task in which no one has been able to accurately determine future requirements. [Ref.53] The frustration level of many of the people involved in the rework process attests to the inability of the NADEPs to provide accurate data to the support installations concerning the required parts. This forecasting is affected by many factors such as: [Ref.18:p.1]

- Engineering Change Proposals
- Power Plant Changes: add new and delete old parts.
- Local Technical Directives: change maintenance requirements.
- Workload Changes: from ASO due to fleet requirements, the condition of fleet aircraft, and budget constraints.
- Depot Make vs. Buy Decisions: alter the requirements due to availability.
- Errors in Demand Projections: the result of numerous factors.

The quarterly forecasted demand received by the Aviation Supply Office (ASO) was often completely different from the previous quarter's demand. One quarter would predict the rework of thirty engines and the next quarter would predict only five. At one point, the actual demand was exactly 180 degrees out from the forecast. As a result, in 1987 ASO decided that forecasting will no longer be utilized in determining the ordering of parts in support of the rework process. Unfortunately, the problem has not gone away. [Ref.53]

The issue of forecasting is a critical one that must be addressed. The Depot needs parts support from the Inventory Control Points (ICP), and the ICP's need accurate forecasting in order to requisition the parts to support the requirements. Forecasting in the past has been the result of predicting future requirements based on past usage. [Ref.18:p.1]

> Depot forecasts have traditionally meant that we examined specific end items in the workload and develop an eight quarter forecast and report to ASO those items that differed from past demand by ten percent (+/-). The forecast was static: it assumed that the past determined the future and that changes would not occur during the two year life of the forecast. Neither are good assumptions. [Ref.18:p.1]

The main issue in the forecasting problem is the need for flexibility in the system.

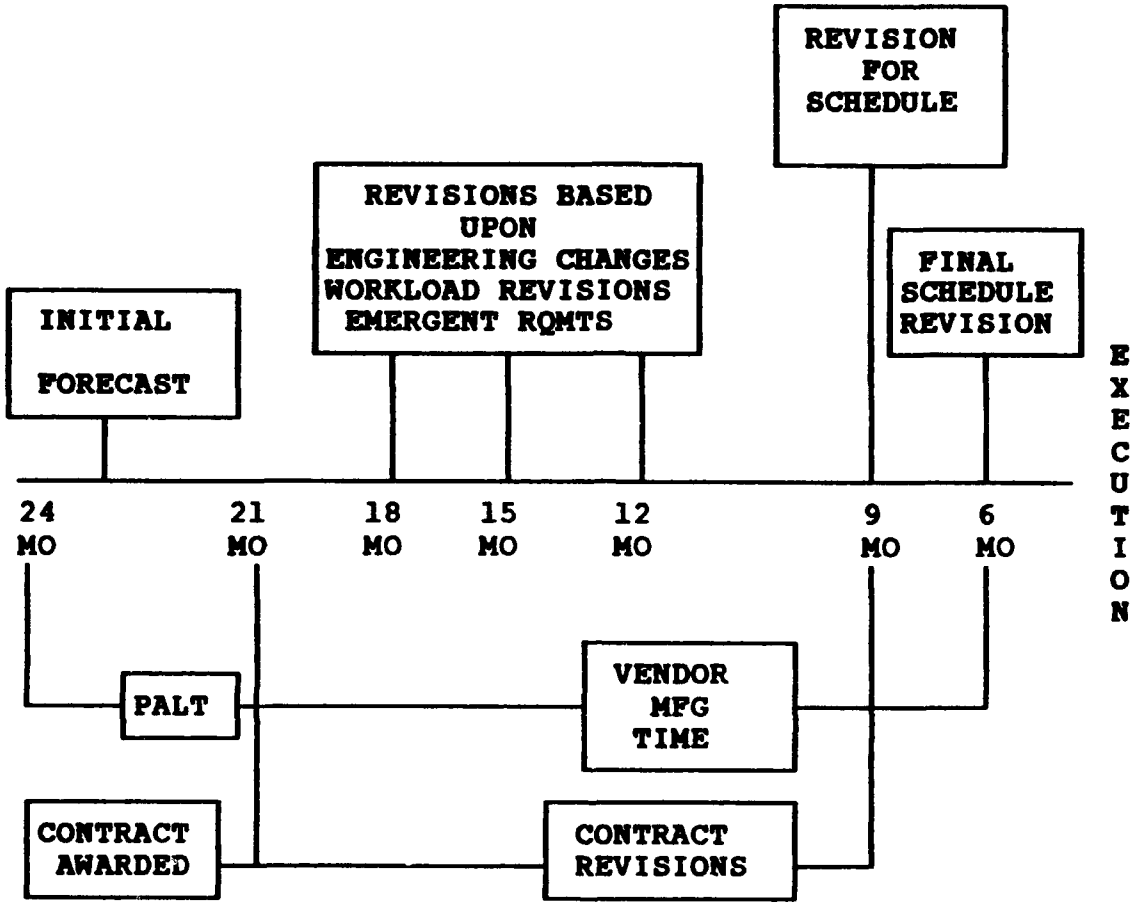
> What is really needed is a new level of partnership with ASO that tightly links ASO with our production floor schedules. The solution is to link our production

> schedules to the bit/piece part demand dynamically; that is we develop a mechanism to reforecast frequently (perhaps monthly) the entire workload based on changes as they occur. Forecasts should cover the leadtime horizon (18 or 24 months), however, their accuracy and our reliance on them will increase as the execution period approaches. A forecast for the 24th month in the future should be treated as a rough cut estimate while the forecast for six months away may be treated as a firm commitment. This is conceptually the same as the Manufacturing Resource Planning II just-in-time delivery process. The activities share demand and forecast data and take necessary actions to protect the estimated production while allowing the plan to change. We make firm commitments towards the end of the process as we lock in workload and demand. [Ref.18:p.2]

The recommendation listed above provides a combination of flexibility and commitment in order to more accurately predict future demand. The "Partnering relationship" discussed in Chapter II must be developed to allow close communications between ASO and NADEP, Alameda. A workable solution will have to incorporate flexibility to allow for the inevitable changes resulting from fleet usage. In addition, commitment must also be a part of the solution to enable the manufacturers to prepare the initial requirements and not be left with excess inventory because of a schedule change. Figure Eight depicts this forecasting model. [Ref.18:p.5]

Due to the fact that Alameda will always replace the 32 parts listed in Appendix A, the forecast will no longer focus on what parts in each of the engines will need to be replaced. Through accurately forecasting the total number of engines, the demand data for the selected parts will, in turn, be determined.

FORECASTING TIMELINE



MINIMIZE TOTAL RISK BY MOVING TOWARDS THE RIGHT >

Figure 8, Source: Cdr. C.P. Grant, NADEP, Alameda, CA.

Without an accurate forecast, it will be difficult to implement the Just-In-Time system at the NADEP at Alameda. JIT has been most successful in the commercial industries that have a continual flow process. In order for success to be achieved at NADEP Alameda, the rework process must be made more predictable in order for the ordering process, lead times, delivery times and schedules to be aligned. Once these

various schedules are determined, the areas of dead time and waste can be revealed and eliminated. Without an accurate forecast, this would be very difficult because there would be no pattern to work with.

The mission of the Department of Defense requires a very flexible system. The events in the past two years have brought about unprecedented change that no one could have foreseen. After a decade of record buildup and investment in our nation's defense, the country begins to look for a peace dividend in the Defense Budget due to the end of the Cold War with the Soviet Union. Six months later we find ourselves in the midst of a war in the Persian Gulf requiring the largest mobilization of forces since World War II. There will continue to be unpredictable changes within the Department of Defense. The System that supports this country's defense must be able to change rapidly and, hopefully in the future, more efficiently.

3. PACKAGING REQUIREMENTS

The implementation of Just-In-Time at the NADEP at Alameda will also require a change of packaging requirements. In the past, the manufacturer, Allison Gas Turbine Div., would pack the engine or engine parts based on information listed on the shipping document. When the item was ordered in the past, there was often no idea as to whether the part would sit on a shelf for five years, or be flown immediately overseas to

support an operational requirement. This has often meant building a wooden crate to house the engine in the event of being shipped overseas. The direct labor cost required to build these crates is $16 per hour and increases the packing and preservation costs to approximately three times the cost to pack the equivalent commercial shipment to a stateside customer. [Ref.11]

Another requirement that has been recently instituted is that of using fire retardant material in the packaging of items being shipped to an overseas location. The initial costs to meet this requirement were exorbitant because Allison had only one source for the fire retardant material. Deliveries were backlogged as a result of the supplier being unable to provide the material to meet the demand because of the new packaging requirement. [Ref.11]

With the implementation of a Just-In-Time process, NADEP Alameda will need to establish more frequent deliveries of smaller lot sizes. As a result, the commercial packaging requirements used in support of Allison's commercial customers will be sufficient to support the line at Alameda. Those items that are destined for overseas locations will receive the fire retardant material and wooden crates. However, the 32 parts being ordered to meet the immediate requirements at Alameda will be able to move more quickly and at less cost through the system.

The clerical aspect of the ordering process can be corrected by informing the buyers of the selected parts and the initiation of the JIT process. When the buyers at NSC Oakland receive the purchase request for one of these parts, they will be aware of the special process and will be trained to place the proper packing and shipping code on the order. In the future, the buyers will equate the JIT process with commercial packaging. The elimination of the unnecessary packing requirements could save the Government a considerable amount of money in the long run.

4. RECEIPT INSPECTION REQUIREMENTS

The Just-In-Time process focuses on monitoring and inspecting the manufacturing process through the use of Statistical Process Control (SPC) and not inspecting the finished product. As a result of utilizing the SPC method to inspect the manufacturing process, the NADEP at Alameda will no longer have to inspect the selected parts upon receipt. In most commercial firms, this is really only a mixed blessing. Although the firm no longer inspects upon receipt, with JIT they must certify the supplier and maintain a close surveillance over the supplier's production process. This process was detailed in Chapter II. The resources saved in deleting the receipt inspection in house can be allocated to monitoring the supplier's process.

The NADEP at Alameda however, is able to take full advantage of this situation. The Government has already established a Defense Plant Representative Office (DPRO) at the Allison plant in Indianapolis, IN. The function of the DPRO is to monitor the production process, inspect the finished product, and ensure the contract requirements are being fulfilled. The DPRO Quality Assurance (QA) Inspectors can be trained in the JIT fashion to monitor the manufacturing process, utilizing SPC, rather than inspecting the end item. By insuring the process is being performed correctly, the DPRO will enable the NADEP at Alameda to reduce the requirements for inspecting the items upon receipt.

The inspections of bearings in the T56 is another area that is slowing down the rework process. The Department of the Navy requires that all bearings must go through first article testing at the Naval Air Station North Island, CA. As a result, the NADEP has to wait up to six months for the results of the tests in order to use the bearings in the rework process. [Ref.10] In addition to the North Island tests, NADEP Alameda also tests all of the bearings upon receipt. The workforce required to support this inspection is significant. This is a prime scenario to implement SPC into the process of manufacturing the bearings, thereby eliminating the additional inspections and reducing the lead times.

5. CONTRACTING METHODS

The method of ordering parts in support of the rework process at Alameda must be overhauled completely. Due to the inability of the forecasting techniques listed above, the NADEP orders parts based upon generation of the need. Rather than having the part on hand, the part is not ordered until the inspector at E&E determines that the work is even needed. As a result, there are instances where the NADEP is required to make urgent buys and pay expediting costs because of the short lead times involved. [Ref. 10]

In order to implement Just-In-Time at the NADEP at Alameda, the Supply system must be made more responsive. Given the nature of the rework and the inability to determine what the specific requirements will be ahead of time, the system has to develop methods to react quicker to the urgent requirements. There are numerous stories of NADEP Alameda putting in requisitions for urgently needed parts, only to discover three days later that the Naval Supply Center at Oakland has not been able to requisition the part from the ICP due to an overwhelming workload. [Ref.10] Unfortunately, the prospects for improvement in this system are not good.

The declining Defense Budget has resulted in significant reductions in the workforce both at the NADEP and at many Inventory Control Points (ICP) around the country. This is a trend that most likely will continue. Therefore, a solution to the support system for the NADEP at Alameda must

not rely on or create an additional burden on the dwindling workforce. The following are merely a few of the contracting techniques that could help to resolve the non-responsiveness of the system in the midst of a reduction in force.

a. ***UTILIZATION OF INDEFINITE DELIVERY CONTRACTS***

The use of Indefinite Delivery Type Contracts (IDTC) will provide a solution to the present problems. The present system is ripe with problems. The part is ordered from the Supply Center at Oakland and has to be transmitted to the ICP, which in most cases is located either on the East Coast or the Midwest. The availability of the part is checked and, in the best of circumstances, is taken out of stock and shipped to Alameda. This simple transaction can take up to three days if all goes well. If the part is not stocked at NSC Oakland, there are additional delays. The delays in this process occur at NSC Oakland in transmitting the requirement, the ICP in locating and pulling the part out of stock and in shipping the part to Alameda.

In the event the part is not available at the ICP, a contract must be let for the item. A solicitation must be made and bids must be received in order to award the contract. Finally, a contractor is located who can provide the parts, however his production lead time is six months. The main drive gear, as an example, will not be available to meet the present requirements at Alameda until March 1992. This

present system will never support JIT and is not efficiently supporting the present system at Alameda. There are too many organizations involved in the Supply system. An IDTC would simplify this process.

An IDTC is a contract used in situations where there are uncertainties in the total quantity required or the delivery schedule is not fixed. There are three types of IDTC's: Definite Quantity, Indefinite Quantity and Requirements. [Ref.13:p.291] The Requirements contract would be most advantageous, enabling the NADEP to move towards a JIT process. In utilizing a Requirements contract, the supplier would be required to provide the NADEP with the quantity needed over a specific period of time.

In implementing the IDTC, the Supply Center at Oakland, or the ICP, will establish a supplier who will meet the requirements of the NADEP for a specific period of time. The supplier would have a maximum number of parts that the Government would be able to order. In addition, the Government would agree to purchase at least a minimum amount. [Ref.13:p.291]

In implementing this contract, both the supplier and the Government would negotiate the unit price and the various maximum and minimum levels as well as any other features the parties agreed upon. Once it is in place, the Government would be able to order over the phone to the

supplier, and have the deliveries made in a matter of days in most cases.

The process for selecting this supplier would be patterned after the process listed in Chapter IV and would require additional time up front in establishing the contract. However, once the contract is in place, it greatly enhances the NADEP's ability to get the parts in a timely manner. There is an additional aspect to this contract that will be discussed next.

b. *IMPLEMENTATION OF LONG TERM CONTRACTS*

Another facet of the requirements contract listed above is the length of the contract. In today's contracting shops, most contracts are for short periods of time, either one or two years. By implementing a Just-In-Time process, the Government needs to establish a long term relationship with its suppliers. One simple method of doing this is to extend the length of the contracts to five years. In the case of the T56, this would be advantageous because of the maturity of the program and the assurance that the T56 will be around for a long time.

The number one impediment to implementing the long term contract however, is the Competition in Contracting Act of 1984 whereby Congress mandated that competition will be sought in all purchases of the Government. [Ref.48] This Act has put an enormous burden on the contracting staffs and

greatly reduced their responsiveness to their customers. The great drawback in the Act is the time required for each buyer to solicit and document adequate competition. Many buyers have stated that they know who can provide the parts at a fair price, but instead they must search out additional competition. [Ref.7] The administrative costs of implementing the requirements of CICA often overshadow the benefits reaped in competing the buy. [Ref.48]

The Competition in Contracting Act is law and as a result, we must find ways to make the system work within the law. The immediate solution to the above problem is to compete the contracts that would provide parts support for Alameda for a long term period. In this case, the buyers would be soliciting competition for a five year requirements contract. The companies that win the contracts would have all of the business for their specific parts for the full five years. This is similar to the JIT contracts awarded at Buick and NUMMI whereby the winners of the contracts have the business for the life of the engine. [Refs.39/44:pp.68&78]

The impact of the long term contract is significant. The personnel required to support the contract would be greatly reduced. As mentioned previously, the Supply Department at Alameda would merely phone in the orders to the supplier thereby eliminating the parties in between. The work required to put the contract in place would require significant resources. Since the contract is for a five year

period, however, the buyers would not have to constantly seek out competition each year. The requirements of CICA are also met because the Supplier Selection process utilized competition.

D. IMPLEMENTING JUST-IN-TIME AT NADEP ALAMEDA

Now that the above changes have been identified, the actual implementation of Just-In-Time at Alameda can begin. The important aspect of this implementation is not where to start, but that you start. [Ref.19:p.139] The implementation of JIT requires four ingredients:

1. Top Management Commitment
2. Team Administration
3. Training and Education
4. Interdepartmental Cooperation

1. TOP MANAGEMENT COMMITMENT

It is imperative that Top Management be actively involved in the implementation of JIT at Alameda in order for it to be successful. By learning the process top down, as Dr. Deming instructed, Top Management will provide the impetus for change required by the various departments. [Ref.27:p.2] The average worker has no idea how the new process should work and it is the role of the Top Manager to provide the vision of JIT at the NADEP. Once the information filters down to the Production Managers, Quality Control Inspectors, Shop Foreman

etc., the lower level workers will eventually understand how JIT affects their daily routine.

In addition to the Top Management at Alameda, support for the implementation must also come from all levels in the Department of Defense. All of the commands listed in Chapter III are needed to support the implementation and provide the resources needed to make it work. By using Alameda as a test study, the Department of Defense can prove that in utilizing commercial methods of production when applied to a rework facility, substantial savings in time and money can be reaped. In times of shrinking Defense Budgets, this initiative to implement cost saving methods should be well received.

2. **TEAM ADMINISTRATION**

The most effective means of implementing JIT is with a team of JIT experts taken from each of the major departments. The purchasing representative/buyer is probably the most qualified member to lead the team due to the overview that purchasing has over the whole organization. [Ref.19:p.139] The JIT team will analyze how the process will be implemented. They will look at the various stations to determine the sequence for implementing JIT seeking to reduce the impact on the present workload. By utilizing a team approach, a synergistic effect can be experienced as each of the team members provides input based on their years of experience.

There will be resistance to the changes as discussed before, but the team will be able to determine what are actual impediments and what are man made, the result of job insecurity and unwillingness to change. Each one of the team members will become a spokesman for the JIT process and will be able to relate to the workers in their own departments how JIT can be a more effective and efficient way. In order to have this kind of influence, the members of the JIT team must be highly qualified and well respected. [Ref.19:p.143]

3. TRAINING AND EDUCATION

The implementation of JIT will require a series of training sessions explaining what changes will be made and the order of the changes. Literature must be disseminated to all of the workforce bringing them up to speed on the JIT concept and the success that many firms have experienced with it. Outside assistance should be brought in prior to implementation to train the JIT team and develop the brochures depicting the new process. Northern Telecom hired the services of the JIT Institute of Technology to aid in their implementation of the process. [Ref.23:p.6f]

The point should be made that implementing JIT at the NADEP at Alameda will require a significant investment. During the initial phases of the implementation, many workers will be in training sessions causing a drastic upheaval to the production process. There will be mistakes made as the

adjustment process continues. The cost of implementing JIT can be made more affordable by analyzing it in terms of the long run savings.

4. INTERDEPARTMENTAL COOPERATION

The importance of cooperation and communication between departments at Alameda cannot be overemphasized. The implementation phase will provide ample opportunities for items to fall through the cracks. JIT reduces the lead times and excess inventories readily available making it essential that departments are communicating to ensure the work flows smoothly. The Supply Department is a critical link in this process as they incorporate all of the changes from the environment outside of the NADEP, with those coming from the inside.

The time is ripe for implementing a new and better way of doing business. In any environment change is difficult. By communicating with each of the various departments, numerous minor problems can be corrected before they become major ones. There may be areas that it would be too difficult to implement JIT at this time. By maintaining open channels of communication, these areas can be identified and dealt with properly.

The important point to remember is that a lot of the decisions affecting the workers can be made by the workers themselves. By relying on their past experience in the rework

process, the lower level workers may be able to set up the system the way they think it would work best and produce the desired results. This not only results in continuous improvement, but also instills ownership among the workers thereby improving morale. [Ref.23:p.6F] This is only possible by insuring that communication channels remain open.

E. SUMMARY

The implementation of the JIT process at NADEP, Alameda will be very difficult and there will be numerous setbacks along the way. By changing the way that we presently do business, we can at least start to make a step in the right direction. The areas of evaluating the engines upon receipt, forecasting future demand, packaging, receipt inspection and contracting for the parts required need to be changed in order for JIT to make an impact.

Most of all, the support of the system and the desire to make the change among the workers is imperative. The JIT process is one of continuous improvement and will require a change of the mind set that has in the past stated, "We have always done it this way". The process can always be improved and it is up to Top Management and the JIT team to instill in the workforce the desire to want to continue this improvement.

NADEP, Alameda does not work in a vacuum and there are many other commands that will be required to change their way of doing business in order to support Alameda. Chapter VI

explores the changes that Allison Gas Turbine Division needs to incorporate in order to be the Certified Supplier that JIT requires.

VI. IMPLEMENTING JUST-IN-TIME AT ALLISON GAS TURBINE

A. INTRODUCTION

Having established the formula for implementing Just-In-Time at NADEP Alameda, it is now time to focus attention on the single source for most of the 32 parts analyzed in this study. Although the production process at Allison is well established, there have been signs recently that Allison is changing the way they produce aircraft engines. The company has invested heavily in new manufacturing equipment including the use of robotics in fabricating parts. This innovation on the part of Allison is a very positive sign showing that, although the company is the sole source for many of these parts, they are aware of the potential loss of business to competitors willing to compete for Government contracts.

There are many changes required to effect the implementation of Just-In-Time at Allison. Some of these changes involve processes outside of the actual fabrication of the parts at Allison. These include the DoD Supply System that provides Allison with the parts requirements and restrictions involved in the packaging and inspecting of these parts. Another area that requires change involves the relationship of Allison with its own suppliers. The Supplier Certification process discussed in Chapter II will have to be

utilized by Allison in order to make JIT work for them. Finally, Allison must incorporate the various manufacturing principles of JIT in order to produce the high quality parts demanded of this process. This chapter will explore each of these three areas beginning with the changes to the present DoD Supply System.

B. BACKGROUND

In 1987, Allison Gas Turbines Division was one of many companies solicited by Rear Admiral Eckelberger of ASO to provide alternative ways of doing business with the Government. The solicitation specifically sought to establish a catalog-type series of parts that would be available to the Government at a competitive price and in a shorter leadtime than presently experienced. The use of a Just-In-Time process was one possible option made by Allison to ASO in response to the solicitation. The following factors are considered by Allison to be a blueprint for implementing a Just-In-Time partnering relationship with the Government. [Ref.2:p.1]

C. A BLUEPRINT FOR IMPLEMENTING JUST-IN-TIME

1. ESTABLISHING A JIT INVENTORY

In the area of aircraft engine production, the process is not the continual flow of material experienced at the major auto makers. However, Allison prescribed an inventory level available to the Government with a lead time reduced to two

months. This would allow the Department of Defense to draw down its stocking levels to the two month requirements eliminating a significant amount of excess inventory. Due to the two month lead time, the amount of backlogged material in the system would also be greatly reduced.

Although this proposal does not mirror the process described in the previous chapters of weekly and even daily deliveries, it is a significant improvement from the past. The major focus at this point is to consider this a starting point. The ICP's would now be informed that, for these selected parts, the lead times will be two months, regardless. This will be an impetus in allowing the ICP's as well as the NADEP at Alameda to more efficiently plan their workload. Knowing that they have a specific schedule, they can plan more for the future than ever before.

2. **FASTER INCORPORATION OF POWER PLANT CHANGES**

The difficulty that the NADEP experiences is in the inability to forecast the workload, thereby lining up the parts required to support that workload. [Ref.18:p.1] One of the difficulties of forecasting is incorporating the numerous Power Plant Changes (PPC). There are different degrees of PPC's with the Class I changes being the most stringent. The Class I changes may come about through feedback from the fleet concerning the safety of the aircraft engine and requesting a change to make the engine safer. As a result, the Class I

change will cause the old part that is being replaced to be obsolete.

The process of incorporating the PPC through all of the required channels in Government, until it is finally approved by NAVAIR, may take up to 12 months. Along with the change proposal are the numerous tests that are required to document the change and determine its viability. Even though the PPC has been approved, it may still take months for the assignment of a new stock number for the new part.

The solution to the PPC problem is for Allison to be provided the authority to incorporate the change into their manufacturing process once it has been approved. This would allow them to make the changes faster by assigning a Temporary stock number while waiting for the system to assign a permanent one.

3. DOD CONNECT TO ALLISON CO-OP SYSTEM

The Allison Co-Op system is a computerized electronic business system that the Navy would be required to become a participating user. [Ref.2:p.3]

> The Navy, through Co-Op, will be on-line with Allison's customer ordering system to enter orders as needed and to view information screens which will indicate the quantity of any given item that is available for immediate expedite. The Navy can execute the expedite requirement with absolutely no manual handling. The warehouse will ship the part either that day or the following morning.

An electronic system is a must for implementing Just-In-Time. Although signing up to Allison's system may not be

the solution, electronic communications is a must for a Partnering relationship in today's market. The lead times required for the paperwork to catch up to the ICP's has got to be reduced to allow a more efficient ordering of parts. The electronic system would enable DOD to communicate any changes to parts or schedules that would impact the contract, allowing Allison to adjust its process in a minimal amount of time.

By implementing the Indefinite Delivery Type Contracts listed in Chapter V, NADEP Alameda could communicate their requirements electronically to Allison eliminating the need for telephone orders. In addition to speeding up the ordering process, NADEP Alameda would also have a record of their orders enabling an audit trail to document the process.

The benefits to the Government of investing in the Allison Co-Op system, unfortunately, will only be realized in the contracts dealing with Allison. The Government could not afford to invest in a new system to match every contractor it does business with. An inexpensive system should be established within DoD utilizing ordinary Personal Computers (PC) to allow any contractor desiring to do business with the Government the opportunity. The Naval Supply Center in Jacksonville, FL, has incorporated ordinary modems in their Electronic Assisted Solicitation Exchange (EASE) program. By hooking up to a modem, the contractor can access the electronic bulletin board and bid on contracts. A similar system could be developed with NADEP, Alameda and its

suppliers providing them with real time information on the status of various contracts.

4. PRICING

In his request for inputs from the commercial sector, Rear Admiral Eckelberger was seeking a catalog-type system that the Navy would be able to order from. Allison provides a commercial list price available worldwide to all users, distributors, and the Navy. A discount rate from list price would be negotiated with the Navy and that would be the catalog price that the Navy would pay for the item.

The pricing of the items was the area that caused ASO not to sign up for Allison's proposal. The Navy is a most favored customer w :h Allison and, as such, is given a discount of 42% off of the commercial price. Although that seems like a significant amount, the DPRO at Allison has been able to negotiate a better price in most of the negotiations. The DPRO Commander passed this information on to ASO who decided that it would be more efficient to negotiate through the DPRO at considerable savings, than to sign up for the commercial prices. [Ref.36]

The pricing of these parts is an area that the Government must look at more in depth. In the event of a reduced workforce, DoD may no longer be able to support a DPRO at Allison. In this case, the catalog price, with a substantial discount, may be the most cost effective way for

the Government to proceed. Although the unit price of an item is not one of the main ingredients in the Supplier Selection process listed in Chapter IV, it is a major item in selecting a supplier for awarding a Government contract. In order to meet the requirements of CICA, DoD will have to require competition or rely on Allison's submission of Cost and Pricing Data and negotiate the price based on this data.

5. **UTILIZE A STANDARD COMMERCIAL PACK**

Allison has designed its production line to produce one item for both its commercial customers as well as the Government. Once the item has been produced, the part or engine is segregated in accordance with end user requirements. In the event of a commercial customer, the standard commercial pack is utilized. In the event of a Government customer, the item is packaged and preserved according to the pack code on the contract.

As stated previously, once it has been determined that the part is in support of the line at Alameda, it can be segregated and packaged along with the other commercial parts. This would alleviate the need to pack these parts according to stringent Government requirements at three times the cost. In the event of a shipment of parts overseas, the Government would be charged an additional expense for the fire retardant packaging and the construction of the wooden crate to house the engine. Once again however, the 32 parts listed in this

study are used to support the line at Alameda and would not require the additional packing.

6. **PROVIDE FORECASTING DATA TO ALLISON**

In order for Allison to provide prompt delivery of parts to NADEP Alameda, they will be required to have the data necessary to forecast the Navy's demand. As listed in Chapter V, NADEP Alameda is no longer using forecasting techniques in establishing the demand of their parts because it was felt that the forecasts were never accurate. Allison, however, feels that their years of experience with the T56 engine provides them with the expertise needed to accurately forecast the Navy's needs. As a result, Allison has required that in order to establish this "Just-In-Time" process, they must have access to certain data necessary for them to make an accurate forecast. The following is a list of some of the data required by Allison to support this system:

- Planning Data
- Navy Inventories
- Data on Unusual Requirements
- Operational Introductions
- Phase downs into Guard and Reserve
- Foreign Military Sales (FMS) needs
- Past Usage Data
- Quarterly Reviews-Naval Air Rework Facility and Fleet involvement

By providing them access to the above types of information, Allison is confident that they would be able to forecast the Navy's demand and support it with their production schedule. In an interview with the Executive Director of ASO, Mr. Richard Fitzgerald, ASO had no problems with providing Allison with any of the above information. He echoed the sentiment that, because of their vast expertise in the T56, Allison would be able to do a better job than any of the resources presently available to ASO. [Ref.16]

7. **WARRANTY**

Allison would furnish a 1000 hour or 24 month warranty on all engines and parts. The warranty would start with the installation of the part in the engine. The warranty is not a major issue with ASO in dealing with Allison due to the company's past history of providing excellent support for its parts.

D. EVALUATING ALLISON'S SUPPLIERS

The Just-In-Time process requires not only that the supplier adopt the company's formula for change, but its own suppliers must align itself to the goals of reduced inventory levels, improved quality and continuous improvement. It is self defeating for Allison to produce quality products, if the supplier of the parts used by Allison is not himself producing quality parts.

Therefore, in order for Allison to incorporate Just-In-Time they must implement the Supplier Selection and Certification processes mentioned in previous chapters. Allison is faced with the same challenges as NADEP Alameda of motivating its suppliers to undergo the tremendous change required by many firms to embrace the JIT process. A recent survey of 100 members of the Association for Manufacturing Excellence Inc. provided the techniques listed in Figure 9 that are used to motivate JIT suppliers. [Ref.20:p.21]

1. QUANTITATIVE RATING SYSTEMS

The use of quantitative rating systems was the preferred method of motivating the suppliers to perform in support of a JIT process. "These types of rating systems involved a quantitative evaluation of suppliers' price, quality, and delivery performance factors." [Ref.20:p.21]

A good example of this quantitative evaluation process has been established by the Copeland Electric Company. [Ref46:pp.22-23] In one highly automated plant, Copeland produces over 700,000 high quality hermetic motors per year for use in refrigeration compressors. In this example, the managers of Quality Assurance, Purchasing and Materials work as a team to evaluate each vendor and assign a rating matrix with vendors assigned a specific number.

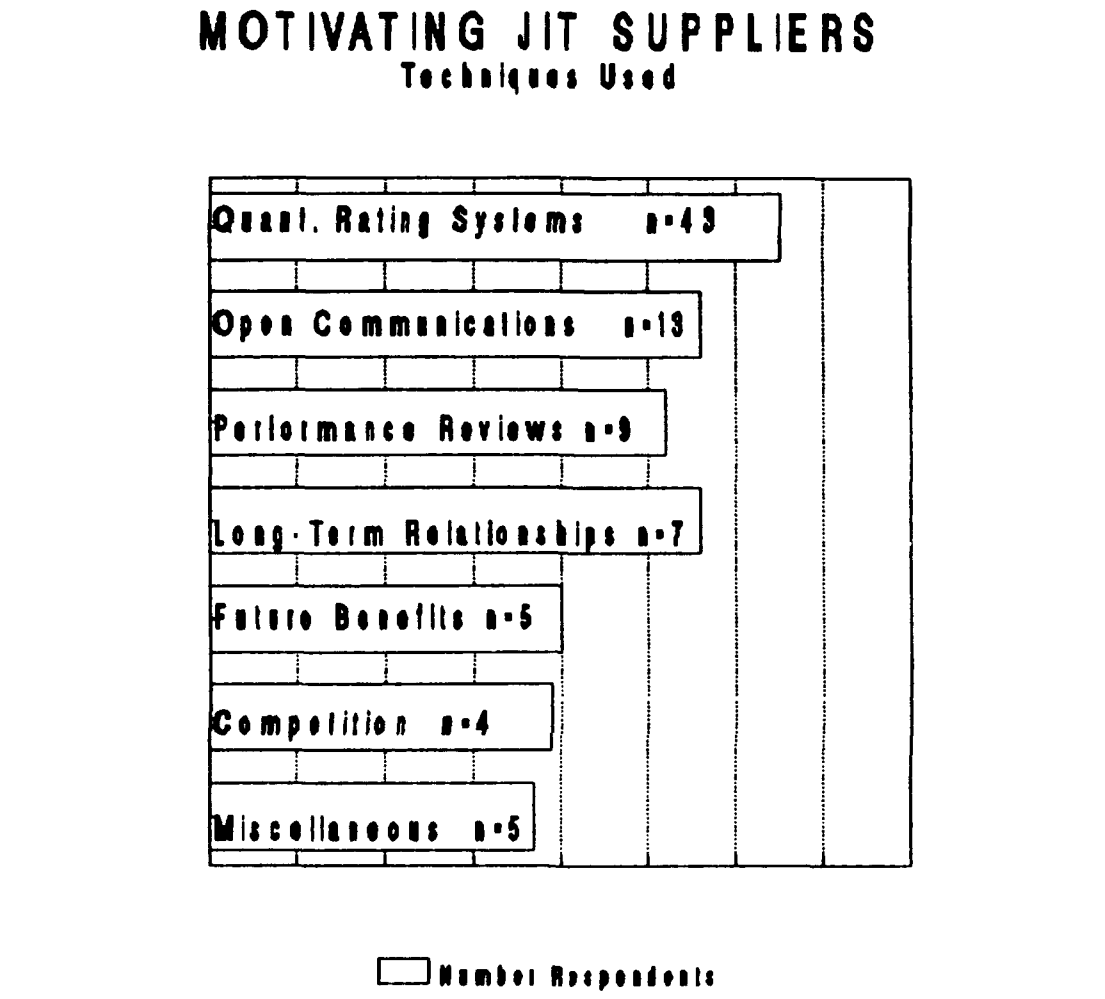


Figure 9, Source: Larry C. Guinipero

The company had reduced the number of vendors in each category to no more than two. Every month each vendor was assigned a score on a scale of 1 to 5 on each rating factor. Rather than having a subjective score applied, they used quantitative measurements. For instance, when shipments are

received either early or late, the vendor received a score based on the number of deviations from the scheduled delivery dates. Paperwork errors such as misbillings, found to cost the company $36 each, were incorporated in the ratings for the vendor that month. The result was a significant improvement in the quality level of each vendor.

2. OPEN COMMUNICATIONS

The need for open communications is evident in every aspect of JIT. Ongoing communications is a key approach in motivating a supplier to perform at the highly rigorous levels required of JIT. As Allison incorporates the new approach, it will have to constantly monitor its own suppliers to ensure that they understand what is expected. The incorporation of SPC into the suppliers' manufacturing process will generate a lot of questions. By maintaining close ties and open communications, Allison will be able to avert bigger problems.

Many firms have adopted an even more dynamic approach to ensuring an open flow of communications between companies. Identified as Just-In-Time II, it involves a representative of the suppliers company working full time in house with the parent JIT company. [Ref.37:p.60] In this example, a senior buyer of G&F Industries reports each day to the Bose Corporation in Framingham, MA. The buyer is allowed to sit in on any design engineering meetings being held at the Bose plant. One of the many benefits reaped by this relationship,

has been the dramatic improvement of communications and purchase order placement. Although Allison may not be ready to make room for a supplier representative in plant, the improved communications between the two parties will help to reduce confusion and motivate the supplier to better performance.

3. **PERFORMANCE REVIEWS**

The use of performance reviews has long been a means of inspecting various units to ensure that they are complying with all the rules and regulations of the job. These reviews, although similar to the rating system, are less quantitative in nature and focus on the development of genuine mutual understanding of buyer-supplier problems. According to the respondents in the survey, these reviews are typically held quarterly or monthly and focus on topics such as schedule development, delivery timing, quality control, pricing, and supplier response time. [Ref.20:p.20] By incorporating performance reviews with its suppliers, Allison could uncover any problems the supplier is having in implementing JIT.

4. **LONG-TERM RELATIONSHIPS**

The reduction in the Defense budget has caused many companies to leave the Defense industry and brought concerns for future business among those companies that have remained in the Defense industrial complex. One of the tenets of the TQM philosophy of Dr. Deming is to drive fear out of the

workplace. [Ref.27:p.2] One of the best methods of driving this fear out is through the commitment of both parties to a long-term relationship. As previously mentioned, this is the carrot that entices a supplier to embrace the changes required of JIT and invest in the future Partnering relationship.

5. SHARED BENEFITS

The aspect of shared benefits is closely aligned with the long-term relationship as a means of motivating the supplier. In an attempt to establish a win-win situation, both the company and its supplier share in the development of future business, the utilization of shared resources, technology, and the potential for increased profits for both firms. [Ref.20:p.22] Allison has the ability to share its tremendous facilities with a supplier in enabling the supplier to perform more research or testing on a certain part. In return, Allison would be able to receive the parts at a reduced rate due to the role that they played in its development. This is one of many possible examples of benefits that could be share' between the two companies, thereby motivating the supplier to perform at a quality level never before achieved.

6. COMPETITION

A few of the firms in the survey adopted the more traditional method of using competition to motivate the JIT supplier. [Ref.20:p22] These firms adopted the hard nosed

approach of demanding the supplier perform at a specific level, or lose the business. In the researcher's opinion, this is not in accordance with the Total Quality Management Approach nor a recommended method of dealing with a Just-In-Time supplier. It is however, being utilized consistently in the Department of Defense in awarding parts support contracts for the T56 engine. Allison unfortunately, has become a target of competition, rather than using competition to motivate their suppliers.

The term "breakout" refers to the practice of taking various parts out of a contract with one firm, commonly a single source, and competing among other firms that are capable of providing these parts. Allison has experienced a significant erosion of their sole source status due to the Air Force's practice of breaking out parts from various contracts and competing the contract among numerous suppliers. [Ref.36] There are many aspects to this practice that Allison is opposed to. [Ref.11]

The practice of breaking out of parts for competition results normally in the contract being awarded to the lowest bidder and does not adequately compare the products. Allison has invested heavily in the manufacturing process and has some of the most sophisticated production and test equipment in the world. As a result, they claim that the supplier that underbids their price and wins the breakout does not have the capability to manufacture and test their product correctly.

The following is a sample of the substantiation tests utilized by Allison. [Ref.1:p.1]

- Dimensional Inspection
- Metallurgical verification
- Engineering Design Specification (EDS) Test
- 300-cycle Accelerated Endurance Test
- 600-cycle Accelerated Endurance Test
- Performance Test
- 1000/2000 Hour Simulated Flight Endurance Test
- Vibration Test
- Overspeed Test
- Burner Outlet Temperature Test
- Burner Rig Test
- Environmental Test
- Blade and Vane Airflow Test
- Thermocouple Performance
- Blanchard Grind Destructive Inspection
- Cold Start/Hot Start Testing

Allison's contention with the breakouts for competition is that the companies that win the contracts are unable to provide the required inspections and tests due to their lack of test facilities. As a result of their investment in these facilities, Allison has to absorb that cost in their overhead, and the burden added to the cost of

making the part pushes them above their competitors' prices. Breakouts have significantly hurt Allison in the area of parts support contracts. [Ref.36]

Realizing the need to confront this breakout trend, Allison has become more competitive. The Aviation Supply Office recently broke out four parts from the T56 engine, turbine vanes, that represent 70% of the cost in reworking the engine due to its constant wear. Normally a sole source item, a new company was found that could also make the vanes. As a result, ASO broke out the four vanes and competed the contract between the two companies for a five year requirements contract. Allison dropped their unit price so low that they had to obtain concessions from their labor union concerning their wage rates, lowering them to enable Allison to compete for and win the contract with a price that was 34% of their commercial price.

The above example identifies the importance that price competition continues to play in the awarding of Defense contracts. The five year requirements contract met the requirements of CICA and provided the Government with a qualified supplier, Allison, at an extremely competitive price. If the lower price causes Allison to streamline their production process and work more efficiently, it will be a step in the right direction for instilling JIT. If however, Allison dropped the bottom out of their labor rates, as some contend, they will not be able to make a profit on this

contract. This is generating the antithesis of a partnering relationship and will not enable Allison to develop into a long-term supplier if they cannot make money. As a result of the pressure that competition is putting on Allison, they must also incorporate the JIT principles in their production process.

E. EVALUATING ALLISON'S MANUFACTURING PROCESS

The above sections have dealt with areas that are outside of Allison's plant that require changes in order to institute a Just-In-Time process. In order to be a true JIT supplier of quality parts to the Government, Allison must also look internally to its production process to determine what must be changed. The T56 has been around for a long time and many of the workers at Allison have been involved with that engine for most of their careers. It will be difficult in this situation to change a process that has worked well for so long. Unfortunately, the above example depicts that Allison will have to find a way to work more efficiently to produce the T56 and its spare parts or find themselves losing a significant share of the market.

The task of incorporating JIT principles into an existing production process is a challenging one that will require a talented engineering team adept at analyzing a process and prescribing the formula for change. There are two steps that are essential to implementing the JIT production process.

They are simplifying the work, and reducing the set-up times. [Ref.19:p.75]

1. WORK SIMPLIFICATION

The work simplification phase builds off of the Value Engineering process that looks at each part and determines if the part is required and how one can add value without adding additional cost to the item. The work simplification process begins by looking at the areas that would have the most impact on the process. In many instances, it is a search for the 20% of the items that account for 80% of the costs and problems. A list is developed and pared down to demonstrate to the various departments the benefits that can be achieved by changing the process in certain areas.

Once the list has been developed, the task involved is broken down into its components. The components can then be evaluated regarding the efficiency of the specific task and if improvement can be made by changing the people, places or sequences of the operation. [Ref.19:p.77] The Industrial Engineer at the DPRO Allison is presently performing this type of analysis. A recent recommendation involved a process whereby two machines located next to each other were assigned two different workers to monitor each machine. The recommendation was made to have one worker monitor both machines, thereby reducing the labor costs by 50%. [Ref.22]

After the task is broken down, each of the components is questioned as to its importance in the process. An analysis is conducted on each step to determine how the process works and why it is performed in the present manner. The data are gathered on each process being examined, and a preferred method of performing the task is developed and implemented.

2. REDUCING SET UP TIMES

Reducing set-up times is, in a sense, a subset of the Work Simplification process. The intent of set-up reduction is to reduce the production set-up times to support smaller lot sizes and improve productivity. [Ref.19:p.81] By reducing the set-up times, it would allow Allison to be more efficient at delivering the smaller quantities that NADEP Alameda and other commands will be ordering as they move closer to the JIT process.

How exactly does Allison reduce the set-up times? As with most every step in JIT, by seeking inputs from the machine users, and developing a team of engineers that will determine the validity of recommendations and help to foster change. With these two ingredients, the set-up of the machines is analyzed by using the following four sub-steps: [Ref.19:p.83]

1) Allocate the proper amount of set-up required to produce quality parts.

2) Determine which steps of the set-up are internal to the machine versus external. What can be done while the machine is still running? Reduce the down time of the set-up.

3) Reduce the time spent in making adjustments to the machine. Position tools and jigs in one motion and standardize the positions.

4) Observe clamping and unclamping motions to uncover lost time. Find methods that require only one or two motions and eliminate the need for tools.

The manufacturing process at Allison must incorporate the above methods as well as embrace the principles of SPC. Allison has already begun to move in this direction. With support from the numerous commands within DOD that are beginning to utilize JIT, as well as their commercial partners, Allison will discover many sources available to assist them in the transition from their traditional manufacturing process to JIT.

F. SUMMARY

The task of implementing Just-In-Time at Allison Gas Turbine Division is a major one that will take years to achieve. While they are looking inward to change their own manufacturing process, changes can be made to the present method of dealing with the Department of Defense enabling Allison to provide greater parts support in a timely manner. The trend in the DoD is for Government to rely more on the public sector. By instituting many of the recommendations made by Allison to ASO, establishing a JIT inventory, faster

incorporation of Power Plant Changes, connecting to the Co-Op system, utilizing commercial pricing and packaging and providing forecasting data, we will move closer to the commercialization of the parts required to support the rework of the T56 engine. In doing so, Allison will be able to respond quicker to DoD requirements without having to rely totally on their Government customers.

The Just-In-Time process is like a chain of events that feed from one into the other. As NADEP, Alameda incorporates JIT, it requires Allison to be able to respond quickly without jeopardizing the high levels of quality. Allison also must insure that their suppliers are motivated to implement the same JIT process that would allow them to reduce their levels of inspection and testing. By certifying their own suppliers and instituting the SPC process internally, Allison may cut some of their own costs, making them more competitive. If not, they may find themselves in the same position as the U.S. Steel manufacturers.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The application of Just-In-Time Contracting practices in the Department of Defense provides a tremendous number of challenges and opportunities to incorporate the efficient practices that have made the Far Eastern countries the manufacturing giants they are today. The challenges are significant, however, and require a thorough study of the JIT process as well as a total commitment on the part of the Top Managers of the Defense Department. The benefits of incorporating this dynamic process will not be realized immediately, in some cases. Nevertheless, through persistant commitment to the continuous improvement processes outlined in the previous chapters, commands such as the NADEP at Alameda, will begin to experience the cost savings and quality improvements that are the hallmark of Just-In-Time.

The improvements will not be restricted to NADEP Alameda alone. As success is experienced at one command, the word will get out to other commands across the country who will learn about the strengths and weakness of Alameda's program. Commands that were once reluctant to change, will observe the successful results of the bold steps incorporated at Alameda, and will pattern themselves after that model. The application

of Just-In-Time is not restricted to any one industry. The principles can be applied across the board, even in the rework of the T56 engine.

B. CONCLUSIONS

1. The Just-In-Time process is a more efficient method of production and is applicable to the rework process at Maintenance and Overhaul Activities in the Department of Defense.

The ability of the JIT method to analyze every aspect of the production and inventory process makes it a viable solution to the rework process as well as many other areas of DoD. Through the elimination of waste and the development of long term relationships, DoD will be able to provide higher quality parts without the burdensome inspection process present in today's system.

2. The process to rework the T56 engine is not efficient and needs to be completely overhauled.

The system to rework the T56 is unable to meet the requirements of the fleet in a timely manner due to the inability to forecast the rework schedules. A significant amount of time is wasted by waiting until the engine is opened to determine what work will be done on the engine. The subjective nature of the E&E inspection does not provide a

consistent end product and inhibits the implementation of a continuous flow process.

3. The DOD Supply System is not presently established to provide Just-In-Time support to the NADEP at Alameda.

As a result of the various Inventory Control Points controlling many of the parts selected for this study, frequent deliveries of smaller lot sizes to the NADEP would be hindered by the significant distances between the suppliers and Alameda. The large number of players in the process impedes the open communications required between the buyer and the suppliers to support the constant changes experienced with JIT.

4. Allison Gas Turbine Division will have to improve the efficiency of their production process in order to be more competitive with other suppliers.

As a result of the reduction of the Defense Budget, more firms will be competing for fewer dollars. The competition between these suppliers will increase significantly resulting in many suppliers leaving the Defense Industry. The suppliers that will remain will be those that have streamlined their production process to eliminate any waste and provide quality products on dependable delivery schedules. If Allison is to remain competitive they must continue to reduce the waste that is presently in their production process.

C. RECOMMENDATIONS

1. Implement Just-In-Time production and contracting practices into the rework process at NADEP Alameda.

The Just-In-Time process will expose those areas of waste that are increasing the NADEPs cost to rework the T56 and other engines. By analyzing and removing these areas of waste, Alameda will be in a better position to compete for and win the DoD rework business for the T56.

2. Utilize competition in awarding long-term contracts to suppliers for the T56 engine.

Although competition is not an attribute of JIT, Congress has mandated that we will use competition for all of our buys. The use of competition has resulted in significant savings in the rework of the turbine vanes. It is possible that there are more areas that this type of competition will reap additional savings to DoD. Once the competition requirement in the selection process is met, establish a long-term commitment with the winning supplier. In doing so, the partnering relationship that JIT builds from will be developed, resulting in improved parts and more efficient production processes.

3. Allison Gas Turbine Division shall incorporate Just-In-Time practices in their production process, as well as require it of their suppliers.

By incorporating JIT and Statistical Process Control in their production process, Allison will enable DoD to reduce the number of Quality Assurance inspectors used to continually sample the end items for compliance to Government specifications. Instead, the DPRO inspectors can monitor the process and the SPC charts to ensure that the parts are being properly and efficiently produced. In addition, Allison will provide their own JIT team to monitor the production process of their suppliers allowing them to reduce their level of inspection. This in turn, will allow the Government to work with Allison to develop more efficient ways of doing business.

4. <u>Implement Just-In-Time buying practices with the Inventory Control Points in the areas of Supplier Selection and Certification.</u>

By requiring the ICPs to incorporate JIT in the solicitation and selection requirements for parts utilized in the rework process at Alameda, DoD will improve the responsiveness of the suppliers to support the line at Alameda. This will result in the long-term contracts providing frequent, on time deliveries of fewer parts in support of the immediate needs of the NADEP. The buyers at the ICPs will, as a result, be spending more time certifying suppliers than constantly seeking out competition for one year contracts. The supplier will in turn develop a relationship

with the engineers at Alameda that will enable them to continuously improve their product and support to the fleet.

5. Utilize commercial products whenever possible to support the rework process at NADEP Alameda.

Due to tremendous reduction in the Defense budget, DoD can no longer ensure the Defense Industrial Base enough business to keep all of the present contractors afloat. By emphasizing the use of commercial products, the contractor can protect himself from a down turn in the Defense orders. Any excess inventory can be used to support his commercial customers. In the event of an increase in demand due to a mobilization, such as Desert Storm, the suppliers will take from their commercial customers to support the Defense needs. This will reduce the risk of the contractors to invest in the Defense Industry.

D. THE RESEARCH QUESTIONS

The conclusions and recommendations listed above address the questions presented in Chapter I. A further summation follows.

1. How can Just-In-Time Contracting procedures be used to the greatest benefit in Maintenance and Overhaul Activities in the Department of Defense?

The greatest benefits of JIT procedures to DOD Maintenance and Overhaul Activities are through the selection

of critical high value and high use parts for applying the JIT process. Similar to the recent turbine vanes contract listed in Chapter VI, these vanes are replaced often and represent a significant portion of the costs to rework the T56 engine. By designating these and similar parts, a supplier can be selected, through a competitive process, to produce the DOD requirements over a long period of time.

2. What is Just-In-Time Contracting?

Just-In-Time Contracting is the process of developing the partnering relationship with a supplier who is willing to submit to the rigorous certification process that ensures the frequent delivery of quality products in small lot sizes over a long period of time. The supplier becomes an extension of the JIT company as both pursue the continuous improvement approach to production. The buyer is the link between both firms and ensures that the supplier is aware of all changes, delivery schedules, modifications etc. In addition, the buyer is the head of the JIT team that frequently visits the suppliers plant to ensure that his production process is producing high quality parts consistently and to look for ways to improve the process.

3. What are the Principal applications of the JIT concept to Navy maintenance functions?

The T56 is an excellent application of the JIT process because of the maturity of the program and the maintenance data available. The programs that would tend to work best with the JIT process are those that have a continuous flow to the rework or maintenance process. By electing to replace various parts every time an engine is reworked, as assumed in this study, a standardized process can be developed and eventually adjusted to eliminate waste both in the parts used as well as the labor involved. The Value Engineering and Statistical Process Control methods will be the techniques used to analyze and refine this process.

4. What problems must be resolved in order to apply JIT procedures in the Naval Aviation Depots?

The evaluation process that initiates the rework of the T56 engine must be standardized as much as possible to enable the continuous flow process of labor and materials. In addition, the response of the supply system to forecast and provide high quality parts "Just-In-Time" for the rework process must greatly improved. The numerous commands that are involved in getting a part from a supplier to the production line at the NADEP must be reduced. The requirement for competition in the supplier selection process greatly impedes the response time of the system and must be reduced as much as possible. Finally, the Leaders of the Navy and the NADEPs

must embrace TQM and the JIT philosophy and encourage the implementation of these philosophies in the workplace.

5. What problems must be resolved in order to apply JIT procedures at Department of Defense contractors?

The implementation of JIT at DoD contractors will require the embracing and support of the TQM and JIT philosophies as well as an emphasis on incorporating these philosophies in the workplace. The DOD supply system must provide its contractors with adequate information to enable them to forecast requirements, especially those items with a long lead time. The contractors, however, must institute Statistical Process Control in their production process thereby eliminating waste and allowing them to compete with the smaller suppliers that are hungry to take their business. They must also institute the Supplier Certification process that will provide them with quality producing responsive suppliers that they can establish a long-term relationship with.

E. AREAS FOR FURTHER RESEARCH

The most striking application of Just-In-Time procedures that could reap immeasurable results is in the area of Hazardous Materials. The stringent requirements for carrying, using and storing Hazardous Materials make it a perfect candidate for Just-In-Time. By selecting a supplier that will

deliver these items in small lot sizes, on a frequent basis, the Department of Defense will put the burden on the contractor. Many DOD facilities do not have the storage facilities or the expertise to handle these items and, as a result, increase the risk of an accident by storing incompatible products together. The feasibility of implementing a JIT contract for Hazardous Materials at the NADEP Alameda, or any DOD installation, would be a study that could provide the solution to a serious problem within the Department of Defense.

APPENDIX A

PARTS LIST

NIIN	NOMEN	PRICE	ICP	SOURCE	PART NBR
008773501	NOZZLE ASSY	282.78	9V	ALLISON	6793640
000658164	TURB FRONT B	748.74	9V	MRC BRG	462808
008773575	HUB SUN GEAR	527.86	9V	ALLISON	6793516
000127215	SLEEVE DIFFUS	455.02	9V	GOV/NEL	6783834P010
001645586	DISK AXIAL CO	2830.12	9V	ALLISON	6858624
001690190	ASSY GEAR DIA	2330.00	1R	ALLISON	6875245
009292455	ASSY GEAR DIA	345.00	1R	ALLISON	6809074P020
011048196	SEAL PLAIN	249.00	1R	ALLISON	6875798
005185071	HOUSING PUMP	342.00	1R	ALLISON	6871877
001598832	VANE ASSY ST	433.66	9V	ALLISON	6859612
001854085	BEARING BALL	748.69	9V	BARDEN	6871643
010313573	GEAR& BEARING	4,390.2	9V	ALLISON	6894129
001828682	BRNG ROLL CYL	1,353.9	9V	ND HYAT	6871650
000652324	COUPLING IN	415.22	9V	ALLISON	6842120
000652332	COUPLING IN	556.52	9V	ALLISON	6842119
000127210	SLEEVE DIFF	543.76	9V	GOV/NEL	6873834P020

NIIN: National Item Identification Number
NOMEN: Nomenclature
ICP: Inventory Control Point
PART NBR: Commercial Part Number

NIIN	NOMEN	PRICE	ICP	SOURCE	PART NBR
00169017	CAGE	623.39	9V	ALLISON	6873728-3
001690178	CAGE	548.01	9V	ALLISON	6873728-4
001690179	CAGE	628.95	9V	ALLISON	6873728-5
001690184	CAGE	384.21	9V	ALLISON	6871864-2
001690186	CAGE	362.14	9V	ALLISON	6871864-4
001690187	FLANGE GEAR	735.23	9V	ALLISON	6873360
002250566	SHAFT ASSY	3995.51	9V	ALLISON	6841228
007296500	BRNG ROL CYL	386.88	9Z	MRC BRG	6829374
011452147	BRNG ROL CYL	2311.9	9V	ND HYAT	6890543
001690164	DIAPHRAM ASS	2804.4	9V	ALLISON	6873667
006083901	SLEEVE DIFFU	289.64	9V	GOV NEL	6783834
000158540	HOUSING IGNI	946.00	7R	ALLISON	6846935
008931321	SUPPORT ASSY	2760.0	7R	ALLISON	23005961
008323357	SHAFT TURB	516.66	9Z	ALLISON	6823505-4
008198469	HOUSING ANTI	289.64	9Z	ALLISON	6809074P010
000719399	SHAFT PROP.	532.93	9Z	ALLISON	6827887

APPENDIX B

ACRONYMS

1. ABOM - Automated Bill of Materials.
2. AGTD - Allison Gas Turbine Division.
3. AIMD - Aircraft Intermediate Maintenance Depot.
4. ASO - Aviation Supply Office, Philadelphia, Pa.
5. CICA - Competition in Contracting Act of 1984.
6. COG - Cognizant Inventory Control Point (Navy).
7. CONUS - Continental United States.
8. CPL - Critical Parts List.
9. DESC - Defense Electronics Supply Center, Philadelphia, Pa.
10. DISC - Defense Industrial Supply Center, Dayton, Oh.
11. DLR - Depot Level Repairable.
12. DMR - Defense Management Review.
13. DOD - Department of Defense.
14. DPRO - Defense Plant Representative Office.
15. E&E - Examination and Evaluation.
16. EASE - Electronic Assisted Solicitation Exchange.
17. EMDP - Engine Model Derivative Program.
18. FMS - Foreign Military Sales.
19. ICP - Inventory Control Point.
20. IDTC - Indefinite Delivery Type Contract.
21. JIT - Just-In-Time.
22. MTBF - Mean Time Between Failure.
23. NADEP - Naval Aviation Depot.

24. NADOC - Naval Aviation Depot Operating Center.

25. NAS - Naval Air Station.

26. NAVAIR - Naval Air Systems Command, Washington, D.C.

27. NSC - Naval Supply Center.

28. NUMMI - New United Motors Manufacturing Inc.

29. PALT - Procurement Administrative Lead Time.

30. PHST - Packaging, Handling, Shipping, Transporting.

31. PPC - Power Plant Change.

32. QA - Quality Assurance.

33. SIMA - Shore Intermediate Maintenance Activity.

34. SPC - Statistical Process Control.

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